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TREATMENT BY MANIPULATION

TREATMENT BY MANIPULATION

A PRACTICAL HANDBOOK FOR THE
PRACTITIONER AND STUDENT

BY

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BEING THE
SECOND EDITION

OF

"MANIPULATIVE SURGERY"

WITH SIXTY-TWO ILLUSTRATIONS

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PREFACE TO THE SECOND EDITION

THE rapidity with which a second edition of this work has become necessary is gratifying evidence of increasing interest in a large and somewhat neglected branch of surgery. Further experience has strengthened the author's conviction, expressed in the first edition, that manipulation **when properly performed in suitable cases** is a method of treatment of extraordinary value.

For the present edition, the book has been thoroughly revised, additional case-histories have been given, and many sections have been re-written and enlarged, particularly those dealing with Osteopathy, Tennis Elbow, Chronic Arthritis, and Lesions of the Sacro-iliac Joint.

The author has attempted to approach the subject of manipulation from his view-point as general surgeon, and in the cases where it has been considered that open operation or other measures would yield a more satisfactory result, this fact has, as far as possible, been emphasised.

He has endeavoured to point out the dangers of manipulation in unsuitable cases or when performed by inexperienced persons. This leads to a much debated question. What should be the attitude of the medical profession towards the unqualified practice of the bone-setter and osteopath? It is our duty resolutely to set our faces against such unqualified practice, for there can be no doubt whatsoever that grave dangers attend manipulations performed by persons who have not received a thorough training in anatomy, pathology, medicine and surgery, such as is required before medical qualification in this country by the General Council of Medical Education.

PREFACE TO THE FIRST EDITION

THIS book has been written with the object of again drawing the attention of the medical profession to the great importance and value of manipulative treatment, in the treatment, **in carefully selected cases**, of certain of the sequelæ of injuries and diseases, particularly affecting the joints, muscles, tendons, and fasciæ. The attitude of many of our profession towards this realm of surgery has perhaps, in the past, savoured a little of apathy and indifference, or even of incredulity. Some of the workers in this subject have held no medical qualification, but nevertheless some of their results point the moral that we as a profession owe a duty, not only to the public but to our own self-respect and prestige, to place this therapeutic measure upon a firm foundation. Let us be honest and give these men recognition for an occasional success, never forgetting, however, the disasters and disappointments that frequently happen, owing to their inevitable lack of clinical training, and in most cases profound ignorance of anatomy. One, not infrequently, finds misapprehension among our profession as to what manipulative treatment means and what it can achieve. Some, indeed, consider that it is a crude form of "wrenching," in which there is a haphazard application of brute force. This certainly should not apply to its practice by qualified medical men.

There is a tendency in other quarters to emphasise unduly the dangers of manipulation, but if we, as a profession, endeavoured by patient research to place the subject upon a scientific basis, and to stamp out unqualified practice, the "sad examples" would thereby be reduced to a minimum. Intelligent discrimination is as necessary in this as in any other branch of surgery, and to condemn a valuable therapeutic measure "root and branch" because of an occasional

unfortunate result in an unsuitable case, is as logical as to condemn the practice of crossing the road, because sometimes a pedestrian, through carelessness, meets with disaster in so doing.

When the history of this interesting episode in medical progress comes to be written, and when events which are now taking place are reviewed with the medical historian's sense of perspective, a striking fact will stand out. Many authenticated cases existed where the bone-setter had cured, where prolonged treatment by our profession, even by its most eminent professors, had failed. Yet the profession, with certain isolated exceptions, among whom we must honourably mention Sir James Paget, Wharton Hood, Lucas Championnière, Sir William Bennett, and Sir Robert Jones, "put its telescope to its blind eye," and declined to make any serious effort to find out "what there was in bone-setting," or to place the subject upon a scientific basis. In medicine, as in other branches of Science, there is nothing more pernicious than a slavish adherence to dogma and tradition. Progress must be our watchword. We can learn a lesson in this respect from John Hunter. "Never ask me," he said to a pupil, "what I have said or written, but ask me what my present opinions are, and I will tell you." Sir Astley Cooper once reminded Hunter that in a previous year he had expressed a different opinion. "Very likely I did," replied Hunter. "I hope I grow wiser every year."

A fundamental reason for the prevailing unsatisfactory state of affairs lies in our ignorance of fundamental facts concerning the anatomy, physiology, and pathology of the articulations. How can we be sure whether to rest or move a joint when our knowledge of the physiology of the joints is almost medieval, when anatomical points are still undecided, and when our knowledge of pathology is so deficient?

It will be the author's endeavour to trace the historical steps by which the tradition of prolonged rest following injury arose. Thereafter, to describe shortly the types of cases that can be cured by manipulation, with their pathology, diagnosis, and treatment. An attempt will be made to point out the

contra-indications and potential dangers, and finally, a number of illustrative cases will be cited.

The kindness and encouragement that the author has received from innumerable sources in the preparation of this book have been an unforgettable experience, and make it difficult to tender individual acknowledgments.

Special acknowledgment, however, is due to my friends Sir Arthur Keith and Sir Robert Jones for help and valuable suggestions, and to the Medical Research Council, under whose ægis much of the work has been done.

CONTENTS

	PAGE
PREFACE TO THE SECOND EDITION - - -	v
PREFACE TO THE FIRST EDITION - - -	vii
CHAPTER	
I. SOME OBSERVATIONS UPON TREATMENT BY MANIPULATION - - - - -	I
II. PATHOLOGY - - - - -	12
III. DIAGNOSIS - - - - -	22
IV. TREATMENT: GENERAL PRINCIPLES - - -	29
V. TREATMENT: LOWER EXTREMITY - - -	40
VI. TREATMENT: UPPER EXTREMITY - - -	115
VII. TREATMENT: MANIPULATION OF THE SPINE -	153
VIII. TREATMENT: MISCELLANEOUS - - -	168
IX. DANGERS OF MISAPPLIED MANIPULATION -	186
X. NOTES ON AFTER-TREATMENT - - -	191
INDEX - - - - -	193

Treatment by Manipulation

CHAPTER I

SOME OBSERVATIONS UPON TREATMENT BY MANIPULATION

THE origin of bone-setting is lost in the mists of antiquity. Long before dissections were practised the art of reducing dislocations had reached a high standard, and the work of Hippocrates on dislocations has scarcely been surpassed at the present day. In the time of the Roman republic we learn that Cato the elder practised bone-setting on his estate. From his "De Re Rustica" we learn that in reducing a dislocation he made use of the following weird incantation: "Huat hanat ista pista sista damiato damnaustra." We smile, but is not the subject of manipulation even in this twentieth century still surrounded by a cloud of mystery and imagination which not infrequently brings discredit upon our profession?

During the passage of the centuries surgery gradually, and by slow and painful stages, became regularised and systematised, and its ranks became closer owing to the formation of colleges and corporations. During this long period the bone-setters were the recognised practitioners of orthopædic surgery. In 1745 the surgeons sought sanction from Parliament to be set free from their colleagues of the old City Guild or Company the "Masters or Governors of the Mystery and Commonalty of the Barbers and Surgeons of London," and thereafter were named "The Master, Governors, and Commonalty of the **Art** and **Science** of Surgeons of London," which, early in the nineteenth century, became the Royal College of Surgeons of England. The object underlying this divorce lay in the fact.

as Sir Arthur Keith has said, that the surgeons of London, had made up their minds to have done with "mystery"; henceforth there were to be no private, secret, occult practices, but a common fund of knowledge to which all might have access.

The ideal of a common fund of knowledge has never appealed to bone-setters for reasons that are best known to their own consciences; neither do they give demonstrations or write books describing their methods.

The first Warden of the new company was William Cheselden, one of the founders of modern surgery. That there was no feeling of ill will or jealousy between the newly-formed company and the bone-setters of the time is clear from the fact that Cheselden himself was in the habit of sending cases of deformity to them for treatment. "Children," he says, "are sometimes born with their feet turned inwards, so that the bottom of the foot is upwards. . . . The first knowledge I had of a case of this disease was from Mr. Presgrove, a professional bone-setter, then living at Westminster. I recommended the patient to him, not knowing how to cure him myself. . . . After that, having another case of this kind under my care, I thought of a much better bandage which I had learned from Mr. Cowper, a bone-setter at Leicester, who set and cured a fracture of my own cubit when I was a boy."

John Hunter

John Hunter's attitude towards orthopædic problems was characterised by that breadth of vision which was part of his greatness. He taught the value of movements after sprains and other injuries of joints, and showed that inflammation of joints was accompanied by the outpouring of coagulable lymph and the formation of adhesions. He stated: "Nothing can promote contraction of a joint so much as motion before the disease is removed. . . . When all inflammation is gone off, and healing has begun, a little motion and frequently repeated is necessary to prevent healing taking place with the parts fixed in one position." He recognised then that "joint

inflammation must be followed by adhesions . . . but the parts will stretch and the motions again become free by gradual motion and by friction." This recognition of the value of movements was of paramount importance, but it is questionable in the light of modern knowledge whether the movements were instituted sufficiently early, and, unfortunately, Hunter's successors misinterpreted his teaching.

Let us examine this teaching, because it has had a profound influence, and can be directly traced through Hilton and Hugh Owen Thomas to modern times, and let us take as an example a sprain of such a joint as the ankle. This treatment implied keeping the joint at rest until pain and swelling had subsided, and to rely upon subsequent exercises to restore free movement. Unfortunately, a frequent sequel was as follows: an adhesion formed, and this became stretched by a sudden movement, so that acute pain and swelling followed, with all the signs of inflammation. According to the Hilton school, this again demanded rest, and there was a continuation of such occurrences, because it was not recognised that it was the presence of adhesions that actually caused the recurrent attacks of inflammation. Such cases frequently visited bone-setters and were cured.

Let us now examine the other aspect of the argument—viz., that one may quite justifiably and deliberately allow adhesions to form, because the motions will again become free by gradual motion and by friction. Is this true? In certain minor forms of inflammation—Yes. In very many more serious forms of inflammation—No. If further proofs were required, one might cite the thousands of stiffened joints, an aftermath of the Great War, in which this treatment has been followed.

John Hilton.

John Hilton in a sense carried Hunter's teaching concerning rest to greater lengths, but he had no use for massage, movements, or exercises. He was a teleologist, and regarded pain as Nature's signal demanding rest, and overlooked the fact that, although man must submit to Nature in the long run, yet

he has the wonderful power of, to a certain extent, helping, guiding, and controlling Nature. For instance, unaided Nature may cure an acutely inflamed joint and leave it in a position of hideous deformity. In a sense a pestilence may be regarded as a process of Nature, but human ingenuity is gradually stamping out such terrible manifestations of a natural process. Similarly, we may compare the riot of vegetation in a tropical forest through which explorers have to hack their way to the delightful sight of a well-ordered English garden in June.

Hilton stretched his hypothesis to the breaking-point, and overlooked the fact that **the pain of a stretched adhesion may be an indication for movement and not for rest.** To illustrate the wrong value that may be placed upon pain as an indication of rest, a recent case may be described which illustrates a modern method of treating suppurative arthritis. A boy developed acute osteomyelitis of the upper ends of both tibiæ almost simultaneously. In spite of operation and free drainage, suppurative arthritis of both knee-joints followed. Both joints were opened and drained, and active movements instituted from the first. With wonderful fortitude, and in spite of pain, the little patient persisted in the movements, and it was noted that drainage was thereby greatly improved. He made a complete recovery, and has full and painless movement of both knees, and can run and play games. What, we may ask, would have been the result in this case had the Hiltonian philosophy been followed?

H. O. Thomas.

The orthopædic principles of that great man and surgical pioneer, Hugh Owen Thomas, must now be briefly touched upon in so far as they apply to our argument. His important contributions to surgery will never be forgotten, but there is no doubt that he was unduly prejudiced against manipulation. Whatever we may think of his attitude towards this subject, we cannot close our eyes to the fact that largely owing to his splint and its early application, the mortality of fractures of the thigh was reduced during the Great War from 80 to

20 per cent. Sir Arthur Keith puts the matter in a nutshell when he states: "Hilton elaborated the means of securing rest into a system, whereas Thomas made rest his creed and ritual." Hugh Owen Thomas believed that an overdose of rest was impossible. He preached his theory with great zeal. Sir James Paget was criticised severely. His essay, to which we shall refer later, was a "new departure in surgery," and a "schism," and contrary to "the faith as handed down to us by the fathers of our art."

Hunter was born in 1728 and Thomas died in 1891, and between these men Hilton held sway. Thus we see that for more than a century and a half the doctrine of rest for various joint conditions was pre-eminent.

The attitude of H. O. Thomas himself towards manipulation is exemplified by his reply to Sir James Paget's paper in the *British Medical Journal* of January 5, 1867. "For many years after the commencement of my experience in surgery," he states, "I had the opportunity of observing the practice of those who had acquired a good reputation for skill as successful manipulators"; and he goes on to say: "I cannot find suitable cases upon which I would perform the deception known as passive motion." It is difficult to understand his indictment of this measure unless we remember some striking facts. As Sir Robert Jones has pointed out, Thomas based his observations largely upon the havoc the bone-setters of his day sometimes brought about in their manipulation of tuberculous joints. But the bone-setters of those days were far more reckless than now. There were no X rays when Thomas wrote, and diagnosis to the bone-setter was much more difficult. We must bear in mind also that when Thomas preached his crusade of rest, the treatment of joint conditions was appalling, and frequently led to amputation and excision. We may conclude this short review of the views of H. O. Thomas upon manipulative treatment by quoting the following extract from a letter, which shows in a striking manner the other side of the question: "In my own case, after submitting to Mr. Hutton's manipulation, I was instantly relieved from that pain, tension, and coldness

in the joint that I had suffered for six years, and was able to walk. . . . Professional men accounted for the manifest change in my condition on one hypothesis and another, whilst all affected to smile at my ignorance and delusion. . . . I had been lame and in pain, and could now walk and was at ease . . . and had the whole College of Surgeons clearly demonstrated to their entire satisfaction that I could not possibly have been benefited by Mr. Hutton's treatment, my opinion would not have been in the smallest degree shaken by it."

If we attempt to summarise the teaching of Hunter, Hilton, and Thomas, we see that all three men in increasing degree attached extreme importance to rest while the slightest form of inflammation existed in a joint, and we have also seen that pain on movement due to mere muscular stiffness or the presence of adhesions was often considered to be an indication of the presence of inflammation. They realised that during rest plastic lymph became organised into adhesions, but they all held the view that full movements could always be restored by subsequent use. But in addition to the great number of stiff joints caused by this attitude towards synovitis, whether infective or traumatic, it must be remembered that multitudes of such joints were also caused by the "classical" treatment of fractures and dislocations. At the present day it is now gradually becoming realised that this "classical" method was almost everything that was bad. The fractured limb was immobilised in splints for a long period, and no attempt was made to prevent secondary muscular contracture or stiffness of adjacent joints. In the treatment of reduced dislocation every effort was concentrated upon healing the rent in the capsule, and nobody cared if, to achieve this, permanent muscle shortening occurred or the joint became crippled by adhesions. Besides, movement might be painful, and therefore contravened the teaching that pain was Nature's indication for rest. We now know that the pain of early movement is largely due to reflex muscular spasm, and can be largely prevented by appropriate massage of the lightest, gentlest, and most superficial nature, the so-called "effleurage."

Next we come to the consideration of a strange fact. The medical profession, although their method of treatment tended to produce such numbers of stiff joints, almost entirely neglected that vast field—the treatment of stiff joints by manipulation. What was the underlying reason for this neglect? The answer is twofold: (1) The fear of wrenching a tuberculous joint. (2) A disinclination to admit that any good could lie in a method practised by unqualified persons. From time to time disasters occurred owing to the wrenching by a bone-setter of a joint which had become stiffened through tuberculous disease. On the other hand, owing to somewhat defective methods of diagnosis, it appears that a very large number of stiff, swollen joints which were crippled by traumatic adhesions were mistaken for tuberculous disease or “white swelling.” For instance, in 1738, Thomas Simson, Professor of Medicine in the University of St. Andrews, wrote to Dr. Alexander Monro describing “an instance of what is called by our English writers ‘the white swelling of the joints,’ which arose from a most singular cause.” This proved to be a loose body formed of bone and cartilage. It is probable also that many other cases of internal derangement due to mechanical causes were mistaken for tuberculous disease. It seems strange to us, as we look into the past, that because manipulation in a particular group was contra-indicated, this method of treatment should have been condemned, “lock, stock, and barrel.” But a brighter day was gradually dawning. It is one of the glories of our profession that, although there have been long periods during which it has lain bound in the chains of dogma and tradition, yet great and original minds have ever arisen whose lives are governed by the pursuit of truth for its own sake, and who are ready to champion any form of treatment which, although unorthodox, is in their conviction for the good of humanity.

Sir James Paget.

Such a man was Sir James Paget. In the *British Medical Journal*, January 5, 1867, appeared his epoch-making paper entitled “Cases that Bone-Setters Cure.” He enumerated

the types of cases which he was convinced could be benefited by manipulation, and ended his essay with the valuable advice: "Learn, then, to imitate what is good and avoid what is bad in the practice of bone-setters."

He had no hesitation in condemning the prevalent practice of prolonged rest, the origin of which we have endeavoured to trace. "Too long rest," said he, "is, I believe, by far the most frequent cause of delayed recovery after injuries of joints, and not only to injured joints, but to those that are kept at rest because parts near them have been injured." How did his professional brethren receive this heterodoxy? Although Sir James Paget's position as a surgeon with a European reputation was already established, the medical profession listened respectfully and then went on treating joints in the old way. On this subject, at any rate, his was a voice crying in the wilderness.

Wharton Hood.

A few years later appeared a book by Wharton Hood which in many ways was epoch-making, and drew warm praise from Paget himself. Wharton Hood, inspired by the highest motives, and whose whole aim and object was the truly Hunterian one of arriving at the truth for the benefit of his professional brethren, accepted the invitation of the famous bone-setter Hutton that he should learn something of his methods. Hutton was an honest and upright man who was thoroughly convinced of the propriety and efficacy of the treatment which he pursued. His ideas of pathology were a little primitive; in almost every case "a bone was out" and had to be replaced, but his results in many cases were magnificent, although, owing to his lack of clinical training, disaster sometimes followed his manipulation of a tuberculous joint. Patients who had been treated by traditional methods for years would throw aside their crutches and walk briskly away from his door-step. Wharton Hood, after learning his methods, used to assist in treating some of the bone-setter's poorer patients.

Considering that an account of his experience would be

of great value to his professional brethren, he therefore published in the *Lancet*, after Mr. Hutton's death, a series of articles explaining the bone-setter's methods, and pointed out to the members of his profession everything that he had been shown. As he himself stated, "the whole mystery of 'bone-setting' precisely what it could do and where it was useless or injurious, was laid open to the medical profession in the plainest language." The papers were subsequently published in book form as a "Treatise on Bone-Setting." What was the fate of this attempt, to place bone-setting upon a scientific foundation? His work, a most valuable contribution to surgery, was largely overlooked, partly from folly and prejudice because bone-setting was regarded as something not quite respectable, and partly because the teachers of Dr. Wharton Hood's day did not accept them and excluded them from the curricula of the schools. One writer has stated that "if Dr. Wharton Hood had held an appointment in a London hospital and had done his work before students, it would long ago have been universally known and imitated by surgeons. But the actual teachers were not sufficiently prompt to acknowledge and welcome the work of a man who was not a member of their own body, and the students had no opportunity of seeing its value." It was well pointed out in an article in the *British Medical Journal* of September 3, 1910. "Not to go so far back as Harvey, who was denounced by the leaders of the profession in his day as a circulator or quack, we need only recall how the open-air treatment of consumption was ridiculed when the idea was first put forward by Bodington. . . . Famous physicians refused to listen to Pasteur because he was not a medical man; Lister was scoffed at; the laryngoscope was sneered at as a 'physiological toy'; the early ovariectomists in this country were threatened by colleagues with the coroner's court; electricity was looked upon with suspicion; massage within one's own memory was regarded as an unclean thing. Even now the vast field of physio-therapy is largely left to laymen for exploitation."

Coming to the present day we find, in spite of the efforts

of Sir James Paget, Wharton Hood, Sir Robert Jones, Lucas Championnière, Sir William Bennett, and others, that the subject does not receive the attention that it merits. Although in other realms of medicine gigantic strides have been made, manipulative treatment still lags behind. The subject, with a few isolated exceptions, is not sufficiently emphasised in the curricula of our medical schools. There is inadequate research into the fundamental underlying principles, and Mr. Hutton's descendants are still occasionally effecting cures in cases which have baffled some of the most eminent members of our profession. Even if it could be proved that disaster or disappointment **frequently** followed manipulation, and there is no evidence that this is the case, cures are so many and so well authenticated that the subject demands the fullest investigation.

The honour conferred upon a famous living bone-setter by His Majesty the King was the result of a memorial signed by over 300 Members of Parliament and by certain leading members of the profession itself. It might have been considered natural that such an overwhelming demonstration of popular approval would have at last aroused the conscience of the profession. We see, however, very little evidence that such is the case.

But destructive criticism alone is of little real value. The subject must be taught by lectures upon the underlying pathology and by actual practical demonstration in our medical schools and hospitals. The subject is too important to be included with a host of other minor and less important subjects in "courses of practical instruction." In practice this means that it is sometimes overlooked or inadequately treated. The cry is often raised that we must not add fresh courses to the already overburdened medical curriculum, but this is one which **must** be included, which **must** be specifically taught by someone who has acquired the necessary experience, and in which the medical student must produce evidence of having received instruction before qualification. As the field for the clinical training of the medical student increases, as it will increase, by so much must be diminished the period

at present devoted in his preliminary years to the laborious assimilation of certain facts quite useless to him in his future career in medicine. Interests and enthusiasms must be aroused, and the student must be taught and shown that the subject is not dull and uninteresting, but one in which results are perhaps more brilliant than in any other branch of the healing art. Research must be conducted into the underlying physiological and pathological principles; careful records must be kept; the subject must be set occasionally for prize essays; questions must be asked in examination papers or at the examination board; clinical lectures and demonstrations must be given at every hospital, for every out-patient department contains scores of cases which are "crying out" for manipulation. Above all, there must be a fundamental change of outlook—a little more manly breadth of vision and true scientific spirit, and a little less of narrowness, pettiness, and of an attitude which condemns things because it cannot understand them, or because they are practised by persons outside the medical profession.

CHAPTER II

PATHOLOGY

WE may, for convenience, classify the cases that may be cured or benefited by manipulation into four main groups, although certain cases are combinations of one or more groups:

- (a) Cases with adhesions.
- (b) Functional or hysterical cases.
- (c) Unreduced dislocations or subluxations.
- (d) Miscellaneous group.

(a) Cases in which Adhesions are Present.

Pathology.—Adhesions in connection with a joint may be intra-articular—*i.e.*, inside the articular capsule—or peri-articular—which usually signifies contraction of the capsule itself, with secondary shortening of peri-articular tendons and other structures. Peri-articular adhesions may be primary or secondary to adhesions in the joint. Very frequently, intra- and peri-articular adhesions coexist, and in many cases secondary muscular shortening may also be present, associated with scar tissue in the substance of or around the muscle, with loss of its elasticity and contractility. This may form the principal obstruction to movement, as after many fractures and dislocations. In addition, in cases of long standing, all the structures on the side of contraction may undergo adaptive shortening.

There are two principal conditions of joints in which adhesions are particularly liable to develop, although it is important to bear in mind that occasionally no hard-and-fast line of demarcation can be drawn between them:

- (a) Synovitis, both acute and chronic.
- (b) Arthritis, acute, subacute, or chronic.

In synovitis the inflammation is limited to the synovial membrane, whereas in arthritis the articular surfaces or joint ends are also involved. In early cases, the articular cartilage only is involved, but in later, the subarticular bone may also show changes. It is therefore clear that, good as the results of manipulation in this last group may be, they are not so brilliant as in the first class. The prognosis also naturally depends to a certain extent upon the cause of the synovitis or arthritis. Traumatic cases have, as a rule, a better prognosis than those due to infection or toxæmia. In the latter cases the results, however, are often good if the cause has ceased to act, or if measures be simultaneously taken to eradicate this factor.

Intra-articular adhesions are of various types, and it is extraordinary to find in certain cases a marked amount of disability resulting from some comparatively trivial and innocent-looking band. The adhesions may be in the form of thickened and contracted bands of the lining layer of the synovial membrane itself that have resulted from a previous attack or attacks of synovitis. On the other hand, bands of every conceivable shape, size, and thickness may stretch across the joint, connecting two more or less distant portions of synovial membrane, or may connect the latter to the articular cartilage, to an intra-articular ligament or cartilaginous disc. Synovial adhesions are particularly liable to occur at those anatomical sites in every joint at which layers or folds of synovial membrane lie normally in contact, especially in that position which the joint tends to assume when inflamed. The existence of these opposed layers of synovial membrane can be demonstrated excellently by sections through joints, a method of anatomical study which is particularly valuable, and one which might with advantage be more often used. For instance, there is no better way of mastering the complicated anatomy of such a joint as the knee than sections in various planes. By this means synovial recesses may be demonstrated which, like other subjects of great practical importance, sometimes escape notice in textbooks of anatomy.

Some of the commoner sites where layers of synovial mem-

brane are in contact in the position of greatest ease, which the joint tends to take when inflamed, will be dealt with under individual joints.

In more serious cases in which the articular surfaces have themselves been involved in the inflammatory process, leading to a loss of a portion of their structure, adhesions of various degrees of density may stretch between these surfaces and may lead to fibrous ankylosis, and in some cases, cartilaginous or even bony transformation may occur in the masses of fibrous tissue, leading to true osseous ankylosis. The term "true ankylosis" is better limited to those cases where adhesion exists between the articular surfaces, whereas "false ankylosis" arises from causes outside the joint, and involves peri-articular tendons, muscles, fasciæ, skin, etc. In those cases in which intra-articular adhesions have given rise to some quite definite limitation of movement of the joint, it is common to find in late cases secondary contracture of the joint capsule, of adjacent tendons, and even in advanced cases of vessels, nerves, and other important structures.

For instance, a frequent sequel of events is as follows: An attack or attacks of synovitis lead to the formation of intra-articular adhesions. The limitation of movement produced leads to secondary contraction of the articular capsule, which may also be considered Nature's way of preventing any movement which causes painful stretching of these adhesions. Secondary contracture of peri-articular muscles and tendons occurs in severe cases from fibrosis, and the latter in many cases forms perhaps the most potent factor in preventing return of full movement, and is one of the most difficult factors to treat. For instance, in the knee, where flexion is limited, the secondary shortening of the quadriceps tendon may require lengthening by operation, and when extension is limited the hamstring tendons may require similar lengthening. In certain cases the intra- and extra-articular fibrosis may occur concurrently. It is important to bear in mind this frequent sequence of events, as it has an important bearing upon treatment. As we shall see later, the ideal to be constantly borne in mind is to **prevent the formation of adhesions**

if in any way possible, for prevention is better than cure. If intra-articular adhesions have formed, then treatment should be undertaken as early as possible, before permanent contracture of capsule and peri-articular structures has occurred.

Limitation of Movement of Joints due to Extra-Articular Causes.—In the foregoing remarks we have dealt principally with stiffness of joints due to intra-articular adhesions, and have mentioned that in certain of these cases secondary contraction of peri-articular structures may occur.

There is, however, a large and important group of cases in which the limitation of joint movement that exists is due almost entirely to conditions existing outside or even at a distance from the joint. Some of the principal of these conditions may be enumerated as follows:

- (a) Contractures occurring in cases of paralysis.
- (b) Contractures following burns.
- (c) Contractures following prolonged suppuration.
- (d) Contractures due to prolonged functional immobility.
- (e) Contractures due to a slow process of sclerosing fibrositis, such as Dupuytren's contracture.
- (f) Ischæmic contracture.
- (g) Contractures following loss of muscular substance or division of tendons.

In most of these conditions manipulation is often of marked value, provided that it be followed by the after-treatment appropriate to each particular case. It is in this group that a combination of manipulation with tenotomy, tendon-lengthening, or other operation is frequently indicated.

The type of case which has been described above must be carefully distinguished from that in which the limitation of movement is due to a bony obstruction, as after many fractures into or in the neighbourhood of joints and in certain cases of chronic arthritis. In many of these cases the limitation is due to both scar tissue and bony obstruction, and manipulation combined with open operation may be of marked benefit.

Mode of Formation of Adhesions.—It is clear that it is difficult or impossible to achieve our ideal of preventing the formation of adhesions unless we have some knowledge of what an adhesion is and how it is formed. Most of us are aware of the ordinary pathological changes that take place in inflammation, and if we apply this knowledge to inflammation as it affects joint structures, we shall see that the phenomena attending the formation of adhesions differ in no very important particular from the phenomena as seen elsewhere in the body. There are the same vascular and cellular phenomena in the synovial membrane and connective tissues of the joint. In the central part of the articular cartilage, which is devoid of blood-vessels, the cellular phenomena greatly exceed in importance the vascular, and the latter may in slight cases be entirely absent.

During an acute attack of synovitis there is an outpouring of plastic lymph from the blood-vessels of the synovial membrane, and those folds and portions of synovial membrane which lie in contact when the joint is at rest tend to become glued together by plastic exudate. If the joint is kept at rest too long, it is easy to see that the plastic exudate will, in all probability, become organised and converted into connective tissue, so that an adhesion is formed. These bands in time acquire an endothelial covering, and become smooth and glistening, and all except the very minute contain blood-vessels. These adhesions may be single or multiple, broad and band-like, thick and fleshy (Fig. 1), form narrow bands or delicate filaments (Fig. 2). There is reason to believe that, as in the peritoneal cavity, an adhesion originally short and broad may by gradual stretching become long and narrow. Furthermore, portions of synovial membrane may adhere not only in the manner above described to other synovial processes, but may contract adhesions to intra-articular ligaments or menisci, or to the articular cartilage itself. This brings us to an important point—viz., in some severe cases of synovitis, and in most cases of arthritis, the articular cartilage may be involved. There is a proliferation of the cartilage cells at the surface, some of which may revert to connective-tissue

cells and mingle with plastic exudate formed by the synovial membrane, so that adhesions which may vary from delicate fibres to those of a dense fibrous nature form between the arti-



FIG. 1.—KNEE-JOINT, IN WHICH THICK, FLESHY ADHESIONS ARE PRESENT, COMBINED WITH CONSIDERABLE DESTRUCTION OF ARTICULAR CARTILAGE.

cular surfaces themselves. In other cases a layer of connective tissue or "pannus" may spread over the articular cartilage from the periphery, where it is derived from the synovial

membrane, and when two adjacent layers of "pannus" become apposed, ankylosis may result.

In some forms of chronic arthritis the pathology differs, particularly in the so-called osteo-arthritis or chronic arthritis of the chondro-osseous type. There may be no plastic exudate, but chronic sclerosing inflammatory changes occur in the synovial membrane and peri-articular structures, so that a



FIG. 2.—DELICATE ADHESIONS IN SUPRAPATELLAR POUCH AND IN VICINITY OF INFRAPATELLAR PAD OF FAT FOLLOWING SYNOVITIS.

slow and insidious shortening and contraction of the connective tissues is brought about associated with gradually increasing deformity. We must also bear in mind that in some cases of severe contusion or fracture into a joint, a hæmorrhagic effusion occurs, and may actually cause or aggravate the condition of synovitis, and in these cases there appears to be a particular risk of adhesions resulting.

The bearing that these facts concerning the birth of ad-

hesions have upon treatment will be discussed more fully in another chapter, but it will be sufficient to emphasise here that, although we cannot always prevent the occurrence of plastic exudate, yet in the treatment of any inflammatory condition of a joint, wherever possible, **movement must be instituted before organisation of the plastic exudate occurs.** Multitudes of stiff joints might have been prevented by attention to this simple but golden rule.

The important question must now be considered: Can prolonged immobility of a healthy joint lead to ankylosis? Hilton, in his classical work, stated that he believed this theory to be untrue. He agreed that changes probably took place in the cartilage, ligaments, and muscles, but believed that such deteriorations were only temporary, "for reparation is perfected in all these structures by careful and steadily increasing use or employment, and after a time they show no defect." H. O. Thomas held similar views. He considered that stiffness of the knee which so often follows a fracture of the femur could not be adduced as an instance of stiffness following immobility of a normal joint, for he argued that the knee in such cases had been injured at the time of the fracture. It is probable that actual adhesions between the articular surfaces only very rarely result from enforced immobility of a normal joint in the absence of adjacent sepsis. However, there can be no doubt that a most troublesome form of false ankylosis may result, which may be even more difficult to treat than a true ankylosis resulting from intra-articular adhesions.

(b) **Functional or Hysterical Cases.**

These constitute a very large and most important class. It is at present only dimly realised what an extremely important part the functional element plays in nearly every joint case. They may be subdivided into four main groups:

1. Cases that are entirely functional.
2. Cases that were functional originally, but upon which from disuse an organic element has become superimposed in

the form of adhesions, fixed muscular contracture, or even arthritic changes.

3. Cases in which a functional element has been superimposed upon a definite organic disease of a joint, such as arthritis, or upon some long-standing lesion, such as intra- or peri-articular adhesions.

4. Cases of malingering upon which a genuine functional element has supervened.

Of these four groups, the third is probably that most frequently encountered, and purely functional cases are less common than is sometimes supposed. The actual pathology of groups 2 and 3 does not materially differ from what we have already described, but clinically there are, of course, very important differences. Only a very careful investigation of the history of a case can tell us whether we are dealing with groups 2 or 3, although this point is of somewhat theoretical interest. It is in these groups, with the possible exception of group 4, provided that the changes are not too advanced and that the mental condition has not become fixed, that some of the most splendid results of manipulation may be obtained.

(c) Dislocations or Subluxations.

The field of manipulative treatment in the reduction of gross dislocations is, of course, very great; as, however, the methods are fully and satisfactorily described in most surgical textbooks, we shall omit the discussion of this subject. *En passant*, it should be borne in mind that it is usually most unwise, and often most dangerous, to attempt the reduction of a dislocation of several weeks' standing by manipulation except when combined with open operation. In these cases, secondary muscle shortening has probably occurred in addition to scarring and contracture at the site of the rent in the capsule. Furthermore, in many cases, as in dislocation of the shoulder, important nerves or blood-vessels may have acquired adhesion to the displaced head, and any attempt

at reduction in such cases is attended with grave risk of injury to blood-vessels and nerves, or of fracture.

Fracture-dislocations of the semilunar cartilages of the knee-joint are a most important field for modern bone-setting, and will be described in Chapter V.

A somewhat similar form of internal derangement may occur in the temporo-mandibular joint, and is often associated with definite mechanical locking.

In medical terminology a subluxation is a partial displacement not amounting to a complete dislocation and the articular surfaces have a relation to each other which they do not assume during the normal joint movements—*i.e.*, the movement is beyond anatomical limits. Such displacements usually occur in arthrodial or gliding joints, and occasionally in other joints. They can readily be demonstrated by radiography. According to many osteopaths a "subluxation" is defined as an immobilisation of a joint in a position of normal motion, usually at the extremity of a given movement.

(d) **Miscellaneous Group.**

Adhesions may occur in other situations in the locomotor apparatus in addition to the joints. They occur frequently in or around muscles, or in fasciæ and connective-tissue layers as the result of injury, such as contusion or sprain, or of the chronic infections and intoxications that we call "rheumatism." In the cases following injury, a hæmorrhagic exudate first occurs, which is gradually replaced by fibrous tissue, whereas in the rheumatic cases collections of inflammatory cells gradually undergo the same conversion.

The pathology of these conditions will be briefly indicated under individual headings.

CHAPTER III

DIAGNOSIS

INTRA- or peri-articular adhesions, such as may occur typically after one or more attacks of traumatic synovitis, usually give rise to the following symptoms and signs:

(a) **Limitation of Movement.**

The most obvious sign of the presence of adhesions is, of course, a certain degree of limitation of movement. In some cases this limitation may be sufficiently obvious to even the most cursory examination, and may be associated with actual **deformity**. In others, however, the limitation may be slight, and very easily overlooked, unless the search be careful and systematic. The importance, therefore, of an accurate knowledge of all the movements of joints, particularly those that are less obvious, can scarcely be over-estimated.

We now come to a point of first-rate importance. How are we to distinguish between the limitation of movement due to some active progressive disease of a joint in which manipulation is usually contra-indicated from the limitation of movement due to adhesions? The answer is twofold. In the first place, we find that in the joint which is the seat of active and progressive changes there is nearly always a limitation of all the joint movements, and that pain and muscular spasm are elicited by these movements from the first. Secondly, we find in the otherwise healthy joint incapacitated by adhesions that the majority of the joint movements may be comparatively free and painless, but that some particular movement is limited, and yet this movement up to a particular point may be free and painless. The limitation of movement

present varies within wide limits, and there should be no difficulty in distinguishing limited movement, due to this cause with its elastic sense of resistance, from that due to bony obstruction. The latter is usually self-evident, although cases commonly occur in which the limitation is due partly to adhesions and partly to bone. This, as we shall see later, very often occurs after fractures, and in chronic arthritis of the osseous type (osteo-arthritis). In the case of the hip, movement may be very markedly restricted, and an X ray of the joint show well-developed osteophytic formation, yet it is astonishing to find in many cases, when such a joint is manipulated under an anæsthetic, how little of the limitation of movement is due to the osteophytes present. The author has experienced this so often, that he considers that an examination under an anæsthetic should always be performed before deciding upon any such operation as the chiselling away of osteophytes, which are alleged to be causing interference with motion. We may conclude by making the somewhat paradoxical statement that those cases in which the presence of adhesions is apt to be overlooked are the very ones in which manipulation is often of the greatest benefit. The actual amount of mechanical interference with movement due to adhesions is nearly always increased by the muscle spasm that is brought about by any movement which might tend to stretch these adhesions.

(b) **Pain.**

It is characteristic that when an adhesion is stretched, pain is experienced. The patient thus learns by experience to avoid the movements that give rise to such stretching and pain. Consequently, the muscles that bring about this movement or movements waste and lose their normal tone, and the muscles that prevent such movements usually present tonic spasm, and may in time undergo adaptive shortening. This tonic spasm may in itself be very painful, and must be abolished by massage, by some special movement, or by anæsthesia before the adhesions can be satisfactorily treated.

A not infrequent symptom of adhesions is nocturnal aching, which interferes with sleep. It is probable that in these cases the muscles are on guard during the waking hours to prevent dragging upon the adhesions. During the complete muscular relaxation of sleep, however, adhesions are apt to be dragged upon, with consequent pain.

It is important to remember that pain may be felt, not only in the joint itself, but may be referred along the course of the nerves supplying the joint.

(c) **Weakness.**

This feature is largely due to the wasting and loss of tone mentioned, and in some cases to laxity of ligaments from recurrent effusions. There is often a complaint of sudden "giving-way" or loss of power in the affected limb, which may cause the patient to fall down or to drop anything that is being carried. These attacks are probably due to reflex muscular inhibition from sudden stretching of adhesions. In other words, a complaint of weakness often means that those movements which pull upon adhesions are instinctively avoided on account of pain.

(d) **Tenderness.**

This is an important feature of adhesions, probably owing to the fact that the constant drag to which they are subjected keeps up active inflammatory changes therein, and also at the site of their proximal and distal attachments. One or more definite tender spots in a joint in which, from clinical grounds, the presence of adhesions is suspected, constitute diagnostic aids of great importance. These tender spots appear to correspond to one or other attachment of the adhesion. In every joint, as we have seen, there are sites of election for adhesions, and the tender spots correspond as a rule with these sites.

Some of the principal sites in individual joints where tenderness due to adhesions is commonly present may be enumerated

as follows, although tenderness may be present almost anywhere:

1. *Hip-Joint*.—Over the head of the femur in the centre of the groin, corresponding to the ilio-femoral ligament.

2. *Knee-Joint*.—Inner aspect of joint over middle of inner surface of internal semilunar cartilage, opposite attachment of deep fibres of internal lateral ligament. Front of joint over infrapatellar pad of fat.

3. *Ankle-Joint*.—Below and in front of external malleolus of fibula; also over extensor tendons on anterior aspect of joint.

4. *Flat-Foot*.—Region of tuberosity of scaphoid.

5. *Metatarsalgia*.—Pressure on under-surface of head of third or fourth metatarsal bone.

6. *Shoulder-Joint*.—Pressure on front of joint in region of tendon of biceps, over posterior and inferior part of joint, or over subdeltoid bursa.

7. *Elbow-Joint*.—Pressure over apex of internal lateral ligament at its attachment to internal condyle of humerus, or on posterior aspect of joint below external condyle.

8. *Wrist-Joint*.—Pressure over middle of wrist anteriorly and posteriorly, or over inferior radio-ulnar joint.

(e) **Recurrent Effusion.**

Although this symptom is encountered in other conditions also, it is a frequent concomitant of articular adhesions. A common sequence of events is as follows: A joint, such as the knee, receives some injury which causes synovitis and effusion. Complete rest is enjoined until effusion has subsided. The patient is then allowed to get up and exercise the limb. This results in further effusion, rest is again prescribed, and the process is sometimes repeated for many months. In the meanwhile, owing to lack of use, muscular wasting, often of a marked nature, ensues, and a vicious circle is thus formed. The author has seen many of such cases where the practitioner has become alarmed and has seriously suspected tuberculous disease. With suitable manipulative treatment—provided, of course, that tuberculous disease is definitely excluded—the patient should soon be walking naturally and without

any tendency to effusion. The presence of such recurrent effusion, when due to adhesions, is usually a sign of some defect in the treatment of the original injury.

Differential Diagnosis.

Under this heading we shall especially consider the important question of differential diagnosis between a case such as we have described in which manipulation is indicated, and other conditions leading to painful limitation of movement of a joint in which manipulation is futile or dangerous. Of the latter, the principal are tuberculous disease of a joint and myositis ossificans.

X-Ray Examination.

An X-ray investigation should never be omitted in any case in which the advisability of manipulation is in doubt. It may show that such a manipulation would be futile, of doubtful value, or dangerous.

For instance, vague symptoms of internal derangement that were considered to be due to adhesions may be shown to be due to loose bodies, where manipulation would be futile. The X ray may show marked destructive changes in the articular ends, where manipulation would be of doubtful utility. It may show the typical features of tuberculous disease, or myositis ossificans, or of a chronic abscess near the joint, in all of which manipulation would be absolutely contra-indicated. X-ray examination of the spine may reveal that an osteopathic or chiropractic diagnosis is false and untenable.

Tuberculous Disease.

There is rarely any real difficulty in excluding most cases of stiff joint due to tuberculous disease if careful investigation be made into the history, symptoms, and physical signs. The patient may have a significant family history, or may present other signs of the disease. The history of gradually increasing disability bearing no very direct relation to an injury, or following an injury, at some considerable interval, is very different to that given in traumatic synovitis, in which the connection can in most cases be directly traced. The some-

what spindle-shaped nature of the tuberculous joint, with the pulpy thickening of the synovial membrane, the raised temperature over the joint, especially after exercise, the very marked wasting that is usually present, and the generally more marked severity of the symptoms, all serve to distinguish tuberculous disease from a traumatic synovitis. Synovial thickening occurs in other diseases, but the uniformity of the swelling and its doughy feeling are characteristic of tuberculous disease; moreover, the wasting is particularly marked and rapid in onset. With regard to the raised temperature over the joint, it should be pointed out that effusions due to various chronic infections and to trauma may show local elevation of temperature, but this tends to disappear much more rapidly than in tuberculosis of a joint. Quervain, an acute observer, states: "Every mono-articular, chronic serous inflammation of the knee, wherein there is definite thickening of the reflected folds of the capsule, and wherein there is a persistent definite local elevation of temperature, must be regarded as tuberculous even if mobility still remains free and pronounced muscular atrophy is absent. Nothing but very clear evidence to the contrary warrants us in departing from this rule of diagnosis." In cases in which the tuberculous process has attacked the articular ends a good radiogram is a particularly valuable aid, and should never be omitted. Clinically, in these cases the presence of starting-pains is often superadded. In a difficult case, certain special tests are sometimes of value, such as the cutaneous reaction of von Pirquet and the complement fixation test.

The cutaneous reaction of von Pirquet: The reagent employed consists of tuberculin 1 part, normal saline 3 parts, containing 0.25 per cent. carbolic acid. The upper arm is cleansed, and two small abrasions are then made a short distance apart. Into the first a drop of the above-mentioned solution is rubbed, whereas the other is kept as a control.

In positive cases redness appears in the infected abrasion within twenty-four to forty-eight hours, and may progress to papule formation.

The complement fixation test is still under trial. The general conclusion is that a definite positive reaction is strong presumptive evidence of an active or recently healed tuberculous lesion, but that a negative reaction will not overrule other definite data. My friend Dr. Douglas has investigated the reaction in 100 male patients suffering from some surgical lesion when tuberculosis was suspected. In the 100 cases the spine, one or more joints or bones were affected in 67 cases, and in 46 of these no tuberculous lesion was noted elsewhere. In the 46 cases there were 76 per cent. positive. In the remaining 21 cases tuberculous lesions were present in one or other organ. In this group the positives amounted to 88 per cent., and the reactions also were stronger.

When synovial effusion is present, a valuable test is to withdraw some of the fluid under strict aseptic technique and inject into a guinea-pig. If tubercle is present, the animal dies of generalised tuberculosis in six to ten weeks.

Histological examination of portions of tissue from the joint, although conclusive in most cases, is seldom applicable in those in which manipulation is under consideration.

The cases, however, which present the greatest difficulty are those in which the disease is no longer active, but has become entirely quiescent, and has left the patient with a stiff joint. Many of the symptoms and signs mentioned above will be absent, tests of doubtful utility, and reliance is placed principally upon the following:

- (a) A careful history of the case.
- (b) The radiographic appearances.
- (c) The usually marked wasting.
- (d) The presence of scars of old sinuses.

In such cases tubercle bacilli may be present in the areas of scar tissue by which they are imprisoned, and manipulation is contra-indicated.

For further details of the above-mentioned and other special tests, textbooks on pathology should be consulted.

The question of myositis ossificans will be dealt with in Chapter IX.

CHAPTER IV

TREATMENT

General Principles.

1. FOR manipulation, the sense of touch, attention to manipulative technique, and after-treatment are probably even more necessary than mere physical strength on the part of the operator, although the latter factor is certainly important, and those who are constantly engaged in such work find it necessary to maintain a high degree of physical fitness. The use of extreme force is never necessary, and may lead to injury to bones, muscles, blood-vessels, nerves, or other important adjacent structures. In those cases in which the adhesions are so dense that extreme force would be necessary, open operation is in most cases to be preferred, or open operation combined with manipulation. Even if damage to adjacent structures could be ruled out of court, the severe reaction caused by the rupture of dense adhesions results usually in a fresh stiffening of the joint, and the result is disappointing. Furthermore, a considerable degree of shock may be caused, particularly in elderly persons, by forced movement in such cases.

2. It is usually desirable to wait for a quiescent period before performing manipulation. This particularly applies to cases of limitation of movement occurring in chronic arthritis. If the condition is still active, as evidenced by signs of obvious inflammation, by the recent onset of arthritis in other joints, and by the presence of some obvious septic focus, manipulation should be deferred until the cause has been eradicated and the acuteness of the symptoms has subsided. We must bear in mind the important corollary that, in cases of synovitis particularly, the acute exacerbations that occur may actually be due to the presence of intra-articular adhesions, and,

therefore, if we are convinced that these are present, we must not hesitate unduly before having recourse to manipulation.

3. As a general rule it may be stated that the results of manipulation vary according to the degree and strength of adhesions and the force necessary for their disruption—viz., the cases in which but little force has been necessary, and in which adhesions were slight, are attended with the best prognosis.

4. In difficult cases it is a sound principle to stay one's hand, and be content with achieving the desired result by a carefully planned series of manipulations, rather than to run the risk of exciting severe reaction and shock by attempting too much at one time.

5. The mere stretching of adhesions is less efficacious than actual disruption, for although temporary improvement may result, the stretched adhesions tend to recontract and shorten, although this can be largely prevented by careful after-treatment. In cases of slight adhesions a series of rapid movements with a long leverage is indicated, whereby the adhesions are ruptured. When, however, adhesions are more dense, movements of a slower and more deliberate nature, with shorter leverage, are less likely to cause fracture, and such movements bring about gradual stretching rather than rupture of the bands of scar tissue.

6. After the restoration of movement to a stiff joint by manipulation, the joint must either immediately or as soon as possible be again moved through the increased range, and this movement must be kept up subsequently at regular intervals to ensure success. This after-treatment is particularly important in the second type described above to prevent any tendency to recontracture. The wasted muscles must also be made to recover by appropriate exercises. The medical man who performs the manipulation should take a **personal interest** in the after-treatment.

7. The very frequent coexistence of a functional element must always be borne in mind, and the importance of firm but kindly handling and of inspiring confidence and keen co-operation in the patient can hardly be over-estimated.

8. When movement, instead of being increased, is actually lessened by manipulation, or if severe pain and reaction follow, it is evidence that either the case was unsuitable for this form of treatment, or that methods were seriously at fault.

9. For successful manipulation, complete muscular relaxation is necessary, and therefore an anæsthetic is desirable, although slight cases can often be successfully treated without an anæsthetic. It is interesting to note that some of the noted bone-setters of the past, such as Hutton, performed their manipulations without this aid, and some of their methods of abolishing muscular spasm were clever.

For ordinary purposes nitrous oxide, either alone or combined with oxygen, is sufficient, as the actual manipulation is usually of short duration, and this method of anæsthesia permits immediate re-education. A skilful anæsthetist can usually obtain perfectly adequate relaxation by these methods.

In more marked cases, and particularly for manipulation of the hip or spine, a longer anæsthetic and adequate preparation are necessary, and it is as a rule inadvisable to perform such manipulations in the consulting-room. In some minor cases, or when a general anæsthetic is contra-indicated, recourse may be had to local anæsthesia.

10. As a general rule, it may be stated that cases of minor stiffness due to adhesions may often be cured by such local measures as radiant heat, massage, and exercises. In marked cases of limitation of movement by scar-tissue the above-mentioned local measures rarely suffice to regain complete range of movement. Other things being equal, it is usually advisable to give these measures at any rate a preliminary trial, and if they do not suffice to bring about a complete cure, the subsequent manipulation is facilitated. It is important to remember, however, that treatment by these means takes considerably longer, and that when a rapid cure is desired, as is frequently the case, recourse should be had to manipulation at once.

In neglected cases associated with marked wasting and general lack of nutrition, a preliminary course of radiant heat and exercises is sometimes desirable.

Manipulation in Functional or Hysterical Conditions of the Joints.

This large and very important group, as we have seen, may be subdivided into several classes, the most important of which are:

1. Cases that are purely functional.
2. Cases in which a functional element is associated with an organic basis.

The medical man must never forget that the nervous system of these persons is in an unstable condition, that they have previously consulted divers others, both qualified and unqualified, and that their whole faith is now pinned upon him. He must prove himself worthy of this trust, remembering that, owing to the peculiar mental state of the patient, some trivial thing may change trust into mistrust, and the golden opportunity is lost for ever. He must take his courage in both hands, and by a judicious combination of tact, sympathy, firmness, and determination snatch victory often out of the jaws of failure. Organisation and personal attention to the smallest detail are essential, and by attention to these points it is often possible to cure completely patients who have been pronounced incurable.

An important principle in this type of case is that immediately the patient has regained consciousness after the anæsthetic, he or she must be firmly convinced that the previously paralysed limb or fixed joint can now be freely moved, and the surgeon must not leave the patient until he has made the latter voluntarily perform the said movements. Thereafter re-education must be carried out regularly, but this must not be of such a nature as again to fix the patient's mind in an abnormal manner upon the joint or limb. In many cases, indeed, the best form of re-education consists in some healthy open-air sport, by means of which the limb is exercised and put through its movements unconsciously while the mind is concentrated upon the game.

Prognosis is influenced by two very important factors.

The first consists in the length of time that the condition has existed. When this is a matter of many years, the prognosis is considerably worse than when the period has been short. Secondly, there is no more difficult or indeed hopeless type of case, than that in which the condition accrues to the patient's financial advantage, as in many compensation cases and in the majority of pensioners. Save in very exceptional cases, it were easier for a camel to go through the eye of a needle than to expect any lasting improvement in such patients—at any rate, while their claims are pending settlement.

Manipulation in Chronic (Non-Tuberculous) Arthritis.

Both in rheumatoid arthritis and in osteo-arthritis limitation of joint movement and deformity are particularly liable to follow. The orthodox principle of treatment consists in use of the joint up to the limit of toleration, and in protection of the joint from further movement by apparatus. Experience has led the author to differ in many cases from this principle. In the first place, what is the cause of such limitation of movement? The answer is, in most cases, adhesions or scar tissue; in others, enlarged synovial processes or fringes. It is claimed that if the painful movement is restricted for some time it will eventually become painless. A commoner sequence is for the adhesions to become more dense, and for the limitation of movement to become permanent. Movement is restrained—often by some form of apparatus—when by careful manipulation the movement might be made complete and painless.

As an example, one frequently sees a patient with chronic non-tuberculous arthritis of the knee with painful limitation of full extension who has been ordered to wear a knee-cage with a stop which prevents complete extension. The author believes this to be an erroneous doctrine in many cases, and has frequently prevented the pain and disability from becoming permanent, and has enabled the patient to discard the instrument by performing manipulation and obtaining full extension. This is subsequently preserved by appropriate after-treatment.

Many years ago Garrod condemned "forced movements" in chronic arthritis, no doubt because he was influenced by the bad results of unqualified practitioners. Physicians, even of the most eminent degree, have since accepted his dictum, and at a recent important discussion on arthritis the learned and distinguished physician who opened the discussion scarcely mentioned manipulation, and then only to warn his listeners against its alleged dangers.

Prevention of Deformity.—During the more acute stages of rheumatoid arthritis, and in many cases of osteoarthritis, muscular spasm exists, and owing to the greater power of certain muscular groups, deformity is apt to occur. Every effort should therefore be made during this stage to prevent such deformity.

If deformity has not actually developed the limb should be placed in that position which experience teaches to be the most useful should ankylosis occur. Unfortunately, the diseased joint, if left alone, usually tends to assume a position that is functionally bad. For example, in the later stages of disease of the hip, the thigh becomes flexed, adducted, and rotated inwards, whereas the best position for ankylosis of the hip is one of extension associated with slight abduction. The knee tends to become more and more flexed and the tibia to become displaced backwards and rotated outwards, whereas the most useful position for ankylosis is probably one of complete extension. The wrist, in untreated cases, becomes more and more flexed, whereas experience teaches that the best position for ankylosis is one of extension. In cases where many joints are involved, the resulting deformities may lead to complete crippledom in neglected cases.

This, however, does not mean that we are to apply a splint or plaster bandages and maintain uninterrupted rest. The retentive apparatus should be removed daily to permit local treatment to the joint and to the whole limb. For this reason, light poroplastic supports may be used. Massage, if given by one who is careful and skilled, is of very great value in most cases. It improves the circulation, maintains the nutrition of the joint structures, and minimises loss of muscular tone and wasting. Applications of ultra-violet rays may be of

much assistance, and careful movements—active rather than passive—tend to prevent ankýlosis.

In those active cases in which deformity has occurred, or in which the tendency to its development is marked, some form of extension may be necessary; this particularly applies to the lower extremity. An important principle in such cases is that extension must always be applied in the line of the distal of the two levers entering into the formation of the joint. If, for instance, flexion of the knee has occurred, the extension must be applied to the leg, and the force must act in the line of the tibia. In practice this means that the thigh must be flexed until the leg is parallel with the bed. Similarly in applying extension to the thigh in disease of the hip-joint, the extending force must act in the line of the femur, and thus the deformity may be gradually overcome.

Pros and Cons of Treatment of Chronic Arthritis by Manipulation.—Under this heading it will be convenient to discuss cases of rheumatoid arthritis, originally acute or subacute, which have become chronic, or cases of a more chronic nature from the first, in all of which “fixed” deformity has occurred. It will be convenient also to discuss under this heading cases of osteo-arthritis, which is essentially a chronic disease.

Speaking in a general way, provided the age and general condition of the patient and other circumstances are favourable, an attempt should always be made to remedy deformity

ERRATUM

Page 35, line 4 from bottom, *for* Osteometies,
read Osteotomies.

ankylosis in a bad position may be remedied by—

- (a) Open or subcutaneous division of contracted bands, or other form of surgical procedure excisions osteometies etc.
- (b) Manipulation.
- (c) Combination of (a) and (b).
- (d) Gradual extension by means of apparatus.

The method to be adopted in any individual case requires very careful consideration. Cases of firm fibrous or of osseous ankylosis are better treated by open surgical operation; if manipulation is performed in such cases, there is grave risk of fracture, of injury to important structures, or of serious shock. The procedure, moreover, is futile, as considerable reaction is excited and the joint promptly restiffens.

In cases of slight or moderate degree of stiffness, however, manipulation is a measure of great value, provided it is performed carefully and gently, with proper attention to technical methods, and with personal attention to every detail of after-treatment.

One frequently hears of the dangers of manipulation, and particularly of the shock that is said to follow this measure. Shock can occur only when either the patient's general condition or the degree of stiffness of the joint contra-indicate manipulation, when excessive force has been employed, or when the method was faulty, as when too much was attempted at one time.

In performing a manipulation upon a joint stiffened by arthritic changes, it is important to bear in mind certain principles:

1. Wait for a quiescent period. If obvious signs of acute or subacute inflammation are present in the joint or joints or some infective focus is present, manipulation should be deferred until the focus has been dealt with as effectively as possible and the acute symptoms have subsided.

2. Manipulation should not be performed unless the general condition of the patient is good, and should be avoided in the elderly and feeble.

3. Where stiffness is marked, an endeavour should be made to restore movement in stages, rather than run the risk of exciting shock and reaction by restoring full movement at one time.

4. In slight cases no retentive apparatus is necessary; in the more marked it is wise to bandage the limb temporarily to a splint in the position of the most useful

maximum movement obtained. In some cases, this entails considerable pain, which the medical attendant must alleviate as far as possible—by morphine if necessary. Massage may be instituted from the first, and at the end of twenty-four hours the splint may be removed and gentle movements started. If there is a tendency to restiffen, the retentive apparatus should be reapplied, but removed daily for massage and movements.

5. A functional element is frequently present in these cases. Firm, kindly, and tactful handling, and the gift of inspiring confidence and keen co-operation in the patient, are assets of inestimable value.

Other Surgical Measures.—There is a large and important group of cases in which limitation of movement and deformity do not constitute the main features. These conditions may be of a minor nature and yet pain, in some cases associated with marked effusion, may be more or less severe. Effusion is, of course, more frequently seen in rheumatoid than in osteo-arthritis, whereas pain is often marked in the latter condition, particularly in elderly people when the hip- or knee-joints are involved.

When a joint such as the knee is the seat of pain and recurrent effusion, without obvious bony changes, a useful surgical measure is to open the joint by one or more small incisions and to wash it out with an antiseptic solution. If, in addition, hypertrophied synovial fringes are present, the incision may be enlarged and the fringes removed with curved scissors. In marked cases a partial synovectomy may be performed. This measure is naturally more likely to be successful if steps are taken to eradicate any obvious focus of infection. There is evidence that this procedure may cut short the disease and probably prevent serious changes. An X ray should always be taken to ascertain the exact condition of affairs and whether osseous loose bodies are present.

Next we come to a common type of case not associated with effusion, but in which irregular osteophytes develop around the articular margins, and destructive changes occur in the more central parts of the articular surface—the more

chronic form of rheumatoid or the typical osteo-arthritic joint. In many of these cases such limitation of movement as exists is due both to mechanical obstruction by osteophytes and to peri-articular scarring.

What is the cause of the pain in these cases? Rational surgical treatment must be based upon the reply to this question. In the writer's opinion, it is due to one or more of four main factors, certain of which may be combined, and all of which may be associated with muscular spasm:

1. Stretching of scar tissue, intra- or extra-articular.
2. Pressure upon osteophytes.
3. Apposition of articular surfaces when covered with sensitive connective tissue.
4. Pressure upon enlarged and tender synovial fringes.

The pain in osteo-arthritis is in most cases due to the first and second of these, while many of the heroic operations sometimes recommended are based upon the assumption that the third factor is responsible.

If we are faced with the first condition a trial should be given to manipulation under anæsthesia. In the second condition, much good may follow operative removal of offending osteophytes. In the hip the operation of cheilotomy is of value if combined with manipulation and followed by early movement and exercises, continued faithfully for several months. Regular movement through full range prevents further osteophytes, should they develop, from interfering with movement.

In the third condition, it is important to remember that in true osteo-arthritis the articular surfaces tend to become eburnated—Nature's way of producing a new articular surface. The pain in these cases is therefore very rarely due to articular apposition *per se*. In the more chronic forms of rheumatoid arthritis, however, pain may be due to mutual apposition and friction of articular surfaces covered with sensitive connective tissue. In this group it is often necessary to decide whether we can do the best possible for our patient by aiming at retaining a movable joint or by producing permanent

ankylosis in the optimum position. A plan of campaign which is often advantageous is as follows:

Endeavour to prevent intra-articular friction by separating the articular surfaces by some form of "de-stressing" splint and limiting the amount of exercise (in the lower extremity). Simultaneously the patient receives general and local treatment to the joint and its musculature to maintain nutrition and muscular tone. Particular attention should be paid to the important principle of carefully putting the joint through its full range of movement daily to prevent contractures. If after a fair trial of such measures the pain is still marked, it may become advisable to induce ankylosis by arthrodesis or excision. These operations should never be lightly undertaken. They are somewhat severe, and in the hip particularly, are associated in many cases with considerable shock.

It must be borne in mind also that the production of ankylosis in a joint not infrequently throws undue stress upon adjacent joints, and may bring about arthritic changes therein. For instance, after ankylosis of the hip-joint, the patient may complain of pain and disability in the lumbar or sacro-iliac regions.

CHAPTER V

TREATMENT : SPECIAL APPLICATIONS, WITH TECHNICAL METHODS AND ILLUSTRATIVE CASES

ALTHOUGH textbooks of anatomy usually describe the various movements that are possible at individual joints, it is very rare to find any mention of the normal range of any particular movement. This is a very serious omission, because it is obvious that **unless a practitioner has a clear idea of the normal range of a movement, it must be difficult or impossible for him to detect minor degrees of limitation.** In this section the technical methods of manipulation for each joint will be prefaced by a brief description of the surgical anatomy and of the normal movements possible at each joint, and the range thereof. In this connection, mention must be made of the extreme importance of always comparing the movements of the joint, wherever applicable, with those of the opposite side. For instance, many individuals normally have a certain amount of hyperextension of the knee-joint. On examining a knee-joint which has received an injury, one might easily conclude that extension was complete because the leg could be extended until leg and thigh were in the same straight line. Examination of the opposite side might reveal that several degrees of hyperextension were normal for the individual. As the knee-joint is most frequently subject to conditions demanding manipulation, it is proposed to discuss this articulation first and in greater detail, and for the reason also that much that will be said is applicable to other joints.

THE LOWER EXTREMITY.

Knee, Hip, Ankle, Mid-tarsal Joint, Toes.

(a) The Knee-Joint.

Surgical Anatomy (Figs. 3, 4, and 5).—For a detailed description of the surgical anatomy of the knee-joint a textbook of anatomy should be studied. The surgical anatomy of the semilunar cartilages has been described by the author in a previous publication.* It is proposed to preface this section upon the conditions of the knee-joint amenable to manipula-



FIG. 3.—CORONAL SECTION OF KNEE-JOINT, SHOWING SYNOVIAL RECESSES ABOVE AND BELOW SEMILUNAR CARTILAGES.

tion, by a short description of the synovial membrane and movements of the joint.

Synovial Membrane.—It must be remembered that this membrane clothes the inner surface of the capsule, and that no sharp line of demarcation can be drawn between these two structures, except in the situations specified below. As a general rule, adhesions following synovitis occur in con-

* "Internal Derangements of the Knee-Joint: Their Pathology and Treatment by Modern Methods." (H. K. Lewis and Co., Ltd.)

nection with that portion of the connective-tissue stratum nearest the joint cavity—viz., the so-called synovial membrane; whereas, in the case of a ligamentous sprain, the scar tissue may be present in the ligament itself, although often associated with true synovial adhesions from concomitant synovitis. Below and anteriorly, the synovial membrane is separated from the capsule and ligamentum patellæ by the infrapatellar pad of fat. Owing to the fact that the synovial stratum clothes the front and sides of the crucial ligaments, but leaves their posterior aspects uncovered, there is an area where the posterior crucial ligament is merely separated by loose areolar tissue from the back part of the capsule.

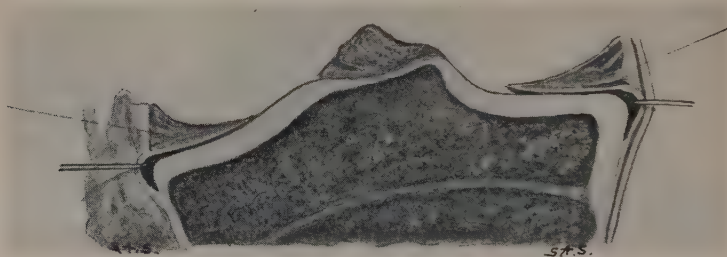


FIG. 4.—CORONAL SECTION OF HEAD OF TIBIA, SHOWING SEMILUNAR CARTILAGES IN SITU.

The synovial pockets beneath the latter are clearly indicated.

The synovial membrane extends upwards for a variable distance beneath the quadriceps extensor cruris, usually communicates with the suprapatellar bursa situated still more proximally, and clothes the intra-articular portion of the femoral diaphysis and epiphysis as far as the margin of the articular cartilage. It clothes both surfaces of the semilunar cartilages, although near the concave edge of the latter it is doubtful whether it can be identified as a definite layer, at any rate in adult life. Shallow synovial pockets are formed beneath the semilunar menisci (*vide* Figs. 3 and 4). It gives a sheath to the intracapsular portion of the popliteus tendon, and by means of this the cavity of the knee-joint may communicate with that of the superior tibio-fibular joint. It

usually communicates with the bursa beneath the inner head of the gastrocnemius and the tendon of the semimembranosus. The ligamentum mucosum is a delicate fold of synovial membrane which passes upwards and backwards from the apex of the infrapatellar pad of fat to the front part of the intercondyloid notch of the femur. Its free margins are known as the ligamenta alaria. It represents what in some animals is

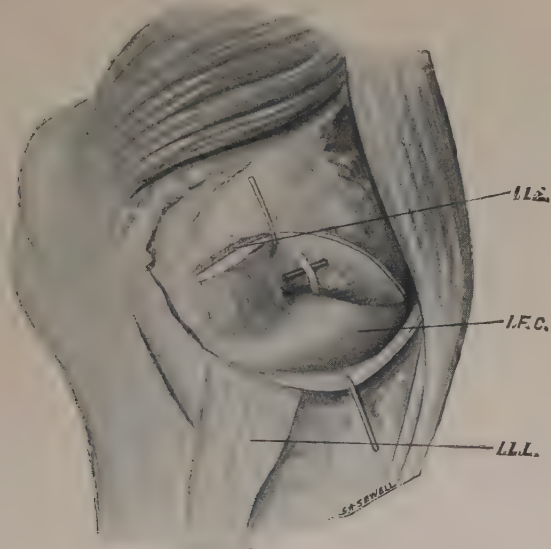


FIG. 5.—SYNOVIAL RECESS BENEATH INTERNAL LATERAL LIGAMENT OF KNEE-JOINT, WITH AN ADHESION IN SITU.

I.L.L. = Internal lateral ligament.

I.F.C. = Internal femoral condyle.

a complete septum, dividing the anterior compartment of the joint into separate portions. Posteriorly, and in relation to the back portions of the corresponding femoral condyles, are well-marked synovial recesses, which communicate on either side by a comparatively narrow channel with the large anterior compartment. The drainage of these posterior recesses in generalised suppurative arthritis constitutes a difficult problem.

Movements (Fig. 6).—*Flexion* is possible until thigh and leg come into contact, and is therefore, to a certain extent, a variable factor depending upon muscular development. It is brought about by the following principal muscles: biceps, semimembranosus, semitendinosus, gastrocnemius, popliteus, sartorius, and gracilis. At the commencement of flexion, there is an internal rotation of the tibia on the femur (or external rotation of the femur on the tibia), brought about by the popliteus, but afterwards the semitendinosus, semimembranosus, sartorius and gracilis assist in this rotatory movement.

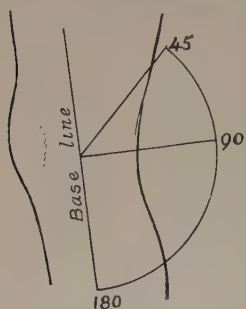


FIG. 6.—RANGE OF KNEE MOVEMENTS.

Extension is possible until the leg and thigh constitute one straight line, although many individuals possess the power of slight hyper-extension of the knee. The movement is produced by the quadriceps extensor, and at its termination, there is a lateral rotation of the tibia upon the femur—the so-called “screw-home” movement.

Rotation is most marked when the leg is flexed to a right angle with the thigh.

Internal rotation is checked by the anterior crucial ligament, and is produced by the popliteus and semitendinosus, and to a certain extent by the semimembranosus, gracilis, and sartorius. External rotation is checked by the internal lateral ligament, and is brought about by the biceps.

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In flexion and extension, the condyles of the femur move upon the upper surface of the tibia and of the semilunar cartilages, and during this movement the femoral condyles not only roll, but glide, “like a cart-wheel hampered by a skid,” according to Goodsir’s classical description. During rotation, movement not only occurs in the aforesaid plane, but between the semilunar cartilages and the head of the tibia.

Indications for Manipulation of the Knee-Joint.

The examples which will be first enumerated are all examples of the after-effects of an exceedingly common form of injury—viz., sprain of the internal lateral ligament of the knee-joint, although much will apply to other sprains of this joint. Afterwards, we shall discuss shortly contusions, lesions of the semilunar cartilages, toxic or infective synovitis, chronic arthritis, combined cases, and functional cases.

Adhesions following Sprain of the Internal Lateral Ligament of the Knee-Joint.

Before discussing the treatment of neglected cases of this injury, in which adhesions have been allowed to develop, it may be helpful to discuss the ætiology and earlier symptomatology of this condition.

An actual complete rupture of the internal lateral ligament of the knee may occur, and is a serious lesion which it is not proposed to discuss here. Sprain-fractures, in which avulsion of the upper bony attachment or occasionally of a portion of the tibia occurs, fall also into this category. Some, but by no means all, of these cases may be associated with a lesion of the internal semilunar cartilage or of the anterior crucial ligament.

There are, however, many cases in which a partial rupture or sprain of the ligament takes place, which may involve its upper attachment to the inner femoral condyle or the deep fibres near their attachment to the middle of the inner border of the internal semilunar cartilage, or more rarely the lower tibial attachment. In some of these minor cases, the tear may be so slight that a player is even for a time able to continue his game. It is in this large group of cases that treatment is in many cases inadequate, and consequently the after-results are not infrequently of a somewhat serious nature, often to the production of a vicious circle.

Mode of Causation.—An injury to the deep fibres is usually produced when, the foot being firmly planted on the ground,

the thigh is forcibly rotated inwards. Injury of the long or superficial portion is nearly always caused by forcible abduction at the knee. Some of the most severe lesions of this portion of the ligament may be produced at football, by another player falling against the outer side of the patient's thigh or leg, while the foot is fixed firmly on the ground.

Symptoms.—In all instances pain, which in the more marked cases may be very acute, is experienced on the inner side of the joint. In many cases, the patient states that a definite "snap" occurred at this site, and in some the history may suggest that true mechanical locking took place. However, on making that careful and painstaking investigation of the history which is of extreme importance in every knee case, it will usually be found that the inability fully to extend the knee-joint was due to pain and muscular spasm rather than to true mechanical obstruction.

Pain and tenderness are always present, their maximum intensity depending upon the exact position of the rupture. They are, therefore, usually present over the upper femoral attachment, or when the deep fibres of the ligament are involved, at the level of their attachment near the middle of the inner border of the internal semilunar cartilage; occasionally tenderness is present at both sites. Tenderness at the lower or tibial attachment is unusual.

In some cases tenderness can also be elicited over the anterior end of the internal meniscus. In severe cases, the pain may be referred upwards into the thigh and downwards into the calf.

Swelling at the site of the lesion may be absent in slight cases. In the more severe a boggy swelling may be soon felt at the site of the rupture owing to the presence of blood-clot. In these cases the hæmorrhagic extravasation may be marked, and the subsequent bruising may extend for a considerable distance upwards into the thigh and downwards into the calf.

Synovial Effusion.—It may be stated as a general rule that the greater the degree of injury to the ligament, the sooner does synovial effusion manifest itself. It may occur almost immediately when the effusion is largely hæmorrhagic. In

cases of average severity, the effusion does not manifest itself for several hours, and is often first noticed upon the morning succeeding the injury.

Limitation of movement is almost invariably present from the first, and this earlier limitation is due to the fact that the movement, being painful, causes reflex muscular spasm. It is obvious that those movements are most painful which stretch the damaged fibres. These are rotatory movements, abduction, and full extension. Flexion is also painful, and this is probably due to the attendant synovitis and reflex muscular spasm.

Loss of Power.—This is an important feature, and apt to manifest itself in various ways, which may often be most disconcerting. For instance, the captain of an international Rugby football team on a visit to this country sprained his internal lateral ligament in a match, but endeavoured to continue the game. At one moment in the game he found himself in a position where it was necessary to run a few yards and fall on the ball to score a certain try, but his limb refused to function and he was unable to move. This sudden muscular inhibition is probably reflex in nature.

Symptoms in Neglected Cases of Sprain.

Limitation of Movement.—On careful examination it will usually be seen, especially if comparison is made with the opposite side, that **full flexion of the knee is slightly restricted**, and attempts to further flex are accompanied by pain on the inner side of the joint. **We may say at once that this limitation is due to adhesions**, but that it is often overlooked because practitioners are not taught the normal range of movement of joints.

Tenderness.—This is present at one or other of two typical sites. One is over the middle of the inner border of the internal meniscus, while the second is over the inner femoral condyle just above the articular margin.

Recurrent attacks of synovitis are frequent.

Loss of Muscular Tone and Wasting.—This occurs with remarkable rapidity, and its treatment and complete cure are

often a very difficult and prolonged matter. Misguided treatment of a knee sprain by prolonged rest may lead to a degree of muscular wasting, which may take many months or even years to remedy completely. In some cases the thigh muscles never recover their original bulk, although the tone may recover, and it may be quite possible for the patient to play strenuous games. It must be remembered that the glutei and tensor fasciæ femoris often participate in this loss of muscular tone and wasting.

Lateral Mobility—*i.e.*, the bending outwards of the leg at the fully extended knee—is commonly present. In severe cases it may be elicited almost at once, but this test should not be performed without the greatest care, as not only is it extremely painful, but further damage may be done to the structures upon the inner side of the joint. In milder cases the lateral mobility occurs later, and is due to stretching of the articular capsule by recurrent effusions and to loss of the normal support of the capsule from weakness of the thigh muscles which act upon it. In testing for lateral mobility the opposite side should always be examined, for in many individuals a slight degree of lateral mobility, or even of hyperextension, is normal, and is compatible with very great strength and activity.

Treatment of Chronic Cases in which Adhesions have been allowed to Develop.

We have already mentioned that in many of these cases we are faced with a set of conditions constituting a vicious circle. The sprain has given rise to synovitis; this causes reflex wasting of the thigh, and the resulting laxity of the capsule still further predisposes to minor traumata of the synovial membrane, synovitis, and delayed absorption of synovial fluid. It should be pointed out that the tenderness over the internal lateral ligament is due to the presence of scar tissue, which may be present, not only in the ligament itself, but in the synovial membrane lining its deep surface, which, indeed, may be adherent to the scar. Now this scar tissue, when stretched, gives rise to a sensation of acute pain

and a reaction in the joint; hence the recurrent attacks of pain and effusion that occur after exercise. The presence of scar tissue in excess is the *fons et origo* of the group of symptoms, and the great principle of treatment is to deal with this, and subsequently to concentrate upon the treatment of the resulting and concomitant conditions. The latter are sufficient in themselves to rise give to serious trouble and a continuance of symptoms, when the internal lateral ligament itself has ceased to be a source of trouble *per se*. When adhesions have actually developed which persist after a fair trial has been given of gymnastic exercises, the vicious circle may be broken and the patient put on the high road to recovery by manipulation.

Manipulation is performed by a sharp movement of flexion, using a long leverage and exercising firm pressure upon the tender spot in the manner described at the end of this section (*vide* Fig. 11). In nearly all cases, the restoration of full flexion is accompanied by a very definite and characteristic snap, as the offending band is ruptured.

In slight cases, this measure is all that is necessary, but in more marked cases the after-treatment is of great importance, and must follow two important lines:

1. The increased range of movement obtained by manipulation must be preserved, and the ground gained consolidated by the patient voluntarily exercising the joint through the increased range at regular intervals, commencing almost immediately.

2. The wasted thigh muscles must be made to recover their tone and bulk by re-education. It will be then noted that the lateral mobility hitherto present will usually disappear.

Pathology of Cure by Manipulation in Cases of Neglected Sprain or Contusion.

The internal lateral ligament is stretched on full extension, but relaxed during flexion. It is difficult, therefore, to explain the actual mechanical limitation of flexion by the presence of scar tissue solely in the ligament itself. To appreciate

better the pathological condition present, the anatomy of the region should be recalled.

Surgical Anatomy.—The relationships of the various parts may be seen from a reference to the accompanying figures (Figs. 3 and 5).

It will be seen that beneath the upper part of the internal lateral ligament near its femoral attachment is a synovial pocket or recess, which forms part of the synovial reflection from the femoral condyle to the capsule.

Normally, the two layers of synovial membrane are in contact, and the internal lateral ligament is in contact with the outer synovial layer.

In ruptures of the long portion of the internal lateral ligament, either partial or complete, it is clear that the synovial membrane must participate therein, and that if the joint be left at rest, the two opposed layers of synovial membrane must become glued together by inflammatory exudate, which may become organised with the formation of a definite adhesion. Furthermore, the outer layer of the synovial membrane must become adherent by fibrous tissue to the scar in the ligament.

There is no greater contributory factor in the formation of these adhesions than prolonged treatment by complete rest, plaster, Scott's dressing, and strapping. In fact, by a prolonged use of these methods, the adhesion of the two opposed layers of synovial membrane is made almost certain.

Another shallow synovial pocket is also present beneath the attached margin of the semilunar, where the synovial membrane lines the deep surface of the coronary ligaments, and is reflected from it to the margin of the tibial condyle (Figs. 3 and 4).

It is probable that after ruptures of the deep fibres of the internal lateral ligament, adhesions are particularly liable to form at this site, giving rise to persistent tenderness.

The tenderness at this site is often quite erroneously thought to indicate a displaced semilunar cartilage, and when, as so often happens, a complete cure results from manipulation in this type of case, the bone-setter has often obtained the credit for curing a displaced cartilage of long standing.

CASE.—In this case the long or superficial fibres of the internal lateral ligament were damaged near their upper attachment.

The captain of an international Rugby football team had been unable to play for some three weeks owing to an injury to his right knee. He stated that another player fell against the outer side of the right knee, and he immediately felt severe pain on the inner side of the joint, but endeavoured to continue the game, although the knee felt weak, painful, and unreliable. There was no "locking" of the joint. At one moment during the game it was only necessary for him to run a yard and fall on the ball to score a certain try, yet he found that, owing to sudden loss of power in the limb, he was unable to move. After the game he noticed that the knee was swollen. He went to a theatre in the evening, and after sitting in a somewhat cramped position and attempting to rise he experienced sudden agonising pain on the inner side of the joint.

He spent the next day in bed, and the limb was massaged, and the effusion soon subsided, but the limb remained weak and powerless, and any exercise such as running caused sudden painful giving-way of the knee. It was feared that his injury would keep him out of the team for the remainder of the tour.

On careful examination it was seen that very slight synovial effusion was present, but there was no tenderness over the internal semilunar cartilage or elsewhere save at one very definitely localised area near the upper attachment of the internal lateral ligament. Full flexion of the knee was restricted and painful. There was slight loss of tone of the quadriceps extensor affecting principally the vastus internus.

The following day manipulation was performed, the joint being put through its full range of movement by a series of short and rapid movements, particular attention being paid to the attainment of full flexion. An adhesion was definitely heard to snap during the latter movement.

A firm compression bandage was worn for twenty-four hours, and the patient advised to take things quietly for this period.

Exercises and re-education commenced the next day, when it was noted that the fluid previously present had subsided (the author has come to regard this as an interesting and common feature after manipulation), and the patient expressed himself as much easier. The movements were now full, although very slight tenderness was still present at the afore-mentioned spot. This, however, disappeared after treatment by ionisation with potassium iodide. Progress was steady, and six days after the manipulation he played in a practice game. Three days later he played against one of the Universities. His progress has been uninterrupted.

Such case-histories bear a striking resemblance to the well-known case in which Mr. Richard Hutton, the famous bone-setter, effected a dramatic cure, and described by Wharton Hood in his book on bone-setting.

“On this the second visit I accompanied him, and what I witnessed made a great impression on my mind. We found the knee-joint enveloped in strapping, and when this was removed, the joint was seen to be much swollen, and the skin shining and discoloured. The joint was immovable and very painful on the inner side. Mr. Hutton at once placed his thumb on a point over the lower edge of the inner condyle of the femur, and the patient shrank from the pressure and immediately complained of great pain. . . . At the expiration of the week Mr. Hutton grasped the limb with both hands round the calf with the extended thumb of the left hand, pressing on the painful spot on the inner side of the knee, and held the foot firmly by grasping the heel between his own knees. . . . Mr. Hutton inclined his knees towards his right, thus aiding in the movement of rotation which he impressed upon the leg with his hands. He maintained firm pressure with his thumb on the painful spot, and suddenly flexed the knee. The patient cried out with pain. Mr. Hutton lowered the limb and told him to stand up. He did so, and at once declared he could move the leg better, and that the previously painful spot was free from pain. He was ordered to take gentle exercise, and his recovery was rapid and complete.”

It is probable that the actual condition originally present was similar to what we have described above—viz., a sprain of the internal lateral ligament, in which, owing to too prolonged rest, synovial adhesions had developed in the region of the synovial reflection from the inner femoral condyle.

Defects in Original Treatment giving Rise to Clinical Syndrome.

The principal defect can be summed up quite shortly, for it consisted in each case in immobilisation for too long a period. Cases of complete rupture of a ligament probably come into a different category, but there is no evidence that early movement in cases of sprain or partial rupture are productive of anything but good, provided the movement be of

the nature of flexion and extension, and that rotatory and lateral movements are avoided at first. The movement of flexion, as it relaxes the lateral ligaments, cannot interfere, if carefully performed, with the process of repair, and the great value of such early movements is that they **prevent the formation of adhesions** between the opposed layers of synovial membrane and between the synovial membrane and the ligamentous scar. It is the failure on the part of our profession to grasp this fundamental fact which has caused, and is causing to-day, the public to consult bone setters.

Contusions of the Knee-Joint.

It is now well recognised, with the more general use of X rays, that many cases of contusion are complicated by fracture into the joint, such as fracture of the patella, vertical fissured fracture of the head of the tibia, or small fragments of bone may more rarely be detached immediately from any of the three bones entering into the articulation and constitute loose bodies.

More frequently, the loose body is due to the gradual exfoliation of a portion of the articular surface by a localised osteo-arthritic process, or by the process that König designated osteo-chondritis dissecans.

A contusion is often the precursor of more generalised osteo-arthritic changes. Myositis ossificans must always be considered as a possible cause of prolonged disability after contusion, and in doubtful cases an X ray should always be taken. In most cases a certain amount of effusion of blood takes place and mingles with the synovial effusion which almost invariably occurs. In the severest cases blood predominates, constituting a hæmarthrosis.

Loose bodies formed of blood-clot may follow this condition, or sometimes the hæmorrhage may occur into a synovial fringe and form a pedunculated loose body.

The infrapatellar pad of fat may undergo slow inflammatory enlargement. A discussion of these most interesting conditions is beyond the purpose and scope of this section.

Concerning one frequently overlooked sequel of contusions—viz., adhesions—a little more must be said.

Contusions, like sprains, are very liable to be followed by synovitis with effusion, and much that has already been said concerning the general pathology of adhesions in cases of sprain applies also to adhesions following contusion. There is, however, a tendency in the latter cases for adhesions to be more generalised, and although they may occur almost anywhere, they tend to be more marked in the front and lower part of the joint, in the region of the infrapatellar pad of fat and its processes, and at the lateral synovial reflections. The adhesions may be of great delicacy and yet potent of much trouble, or may be of a somewhat extensive nature.

Localised tenderness is often present, with limitation of some particular movement or movements. In this connection the movements of the patella laterally and the rotatory and "screw-home" movements should always be tested.

The pathology of this type of case is described more fully in the author's book.*

In the case to be first described, nearly a year had elapsed since the original injury, which was of the nature of a contusion. The striking facts about the clinical picture in this case were the recurrent attacks of pain and effusion after intervals of comparative freedom, and the absence of tenderness either over the internal semilunar cartilage or internal lateral ligament.

CASE I.—An undergraduate Association football player came to me with the following history: He stated that eleven months previously, while kicking the ball, the opposing goal-keeper's shoulder struck the right knee, and there was a general feeling of everything being twisted from right to left. There was no locking of the knee, but afterwards the knee swelled considerably. The doctor whom he consulted considered that the semilunar cartilage had been torn, and put the limb into a plaster of Paris splint. The swelling of the joint gradually subsided, but the thigh and calf muscles wasted rapidly, and the limb felt generally weak and un-

* "Internal Derangements of the Knee-Joint: Their Pathology and Treatment by Modern Methods." (H. K. Lewis and Co.)

reliable, and there was also a distinct feeling of pain under the patella when any strain was put on the knee.

On Examination.—Slight generalised synovial effusion present. Tenderness over infrapatellar pad of fat on firm pressure. No tenderness over either semilunar cartilage or over the lateral ligaments.

Definite wasting and loss of tone of the right quadriceps extensor, principally involving vastus internus.

Movements.—Flexion and extension full, but movements of patella laterally somewhat restricted. Definite lateral mobility present. X ray revealed no abnormality.

Manipulation was performed under nitrous oxide anæsthesia, and the lateral movements of the patella completely restored. After twenty-four hours' rest, no effort was spared either by the patient himself or the masseur to restore the wasted quadriceps. There was no recurrence of effusion, and ere long he was able to play football without ill-effects.

It seems clear that in this case the original injury was a contusion which gave rise to synovitis, that adhesions in the region of the infrapatellar pad of fat resulted, and that gradually the symptoms to which the latter gave rise overshadowed those due to the original injury.

CASE II.—An example of a somewhat similar condition to that described above, but eight years had elapsed since the original injury, and, as so often happens in neglected cases, a functional element had become superadded.

Manipulation is of particular value in this type of case, but it is obvious that the after-treatment must of necessity be somewhat more prolonged than in the less complicated type of case described above.

A young lady was involved in a taxi-cab accident eight years previously, in which she sustained a severe contusion of her right knee.

Much pain and effusion followed, for which a considerable period of rest and strapping were prescribed. When the strapping was at length removed, the knee was not unnaturally very stiff and the quadriceps wasted. This state of affairs was remedied to a certain extent by a long course of massage and re-education, but any exercise brought on effusion and pain in the lower and front part of the joint.

The physical symptoms were so similar to those described above that they will not be described separately.

The functional element was manifested by complaints of scarlet patches over the affected knee during the painful spells. These were actually seen by her medical adviser,

although the joint otherwise appeared quite free from acute signs.

The treatment consisted in manipulation, when, during rotation, the definite snap of a ruptured adhesion was heard. An equally important result was the powerful suggestion of this mode of treatment and its effect upon the functional condition and the breaking-down of a vicious circle. A course of special re-education followed immediately, under which the wasted muscles largely recovered their bulk and tone, and the end result was most satisfactory.

The Simulation of Tuberculous Disease by Traumatic Articular Adhesions.

In some instances articular adhesions following trauma may simulate tuberculous disease somewhat closely, and owing to this fact, many cases for which massage and mobilisation are the correct treatment are treated by immobilisation until troublesome or even irremediable stiffness has occurred. In another chapter the principal diagnostic features of tuberculous arthritis are enumerated. Great difficulty confronts us in deciding whether to prescribe absolute rest or mobilisation in many cases.

The author has found by experience that a golden rule in such doubtful cases is to watch the effect of **very carefully administered** radiant heat, massage, and gentle assisted movements while simultaneously reducing weight-bearing to an absolute minimum.

If this treatment actually relieves pain and disability and brings about improved and comparatively painless movement, at first through a restricted range, it is highly improbable that we have to deal with a case of tuberculous disease. One may, if the treatment continues to give rise to improvement, supplement it and expedite recovery by a series of manipulations when considered advisable.

If, on the other hand, the treatment, although carefully given, causes an increase of pain, spasm, and other symptoms, the possibility of tuberculous disease has to be seriously considered.

The following case illustrates many of these points:

B., aged 15, complained of pain and stiffness of the left knee. Three or four years previously he fell from a fence and sprained the knee, and shortly after injured the joint in a bicycling accident; considerable synovial effusion followed which subsided after complete rest and splintage. Thereafter marked use of the limb caused slight synovial effusion without much pain, but flexion of the knee remained slightly impaired. A series of slight injuries to the knee followed, each being accompanied by synovial effusion and increased stiffness. The last of these injuries was a contusion received five months before reporting. This was followed by a somewhat persistent synovial effusion, pain, and limp. A doctor was consulted who put the patient to bed. The swelling subsided in a fortnight, and after being supplied with a poroplastic splint to keep the limb fully extended, the patient was allowed to get about with crutches. This splint was worn for about four months and then massage and gentle movements were instituted and a little weight-bearing permitted. This, however, caused an increase of pain and a recurrence of swelling. Tuberculous disease was suspected, although the patient's general condition was excellent, and the family history was negative.

On Examination.—A healthy looking boy walking with the aid of crutches and keeping the affected knee rigidly extended. There was no actual swelling of the knee and no raised temperature over the joint. There was considerable limitation of movement, but owing to the marked degree of muscular spasm, it was not possible to state definitely how much of the limitation was due to spasm and how much to adhesions. Tenderness was elicited over the internal lateral ligament in the joint interval, and marked wasting of the thigh was present. X ray revealed no abnormality. Careful consideration of the history and of the signs and symptoms, particularly the absence of heat over the joint, the negative X ray and the patient's excellent general condition, did not support a diagnosis of tuberculous disease, but the condition was considered to be one of adhesions following the series of attacks of traumatic synovitis. Manipulation was accordingly performed. When muscular spasm was abolished by anæsthesia, it was found that the last twenty degrees of flexion were definitely prevented by adhesions. These adhesions were carefully broken down, full flexion was obtained, and the usual after-treatment followed. Three weeks later it was almost impossible to detect any abnormality in the joint. Movement was full, there was no swelling, he was able to walk

without a limp, and the musculature of the thigh had already greatly improved. Permission was given to cycle, and the improvement was steadily maintained.

Manipulation in Chronic or Recurrent Lesions of the Semilunar Cartilages and their Differential Diagnosis.

We are not here concerned with the question of manipulation in original displacements of the semilunar cartilage. It may be mentioned, however, that there is no evidence that early movements after reduction, provided rotation be avoided, are less efficacious in bringing about union than the long period of immobilisation that is often ordered. The latter is apt to lead to the pernicious after-effects of adhesions and wasting that we have noted above.

The author has investigated the problem of repair in the semilunar cartilages experimentally, and has also examined microscopic sections of fractured semilunar cartilages removed at operation at various intervals from the original injury. These investigations all point to the fact that repair is extremely sluggish in the menisci.

In most cases a lesion of the internal semilunar cartilage is in reality a complication of a severe sprain of the corresponding lateral ligament. There will, therefore, be a somewhat similar history to that of sprain, and a certain similarity in the points of tenderness.

Protrusion of the fractured cartilage outwards—*i.e.*, away from the interior of the joint—although mentioned in many textbooks, is excessively rare, but a peculiar “rumble” or “snap” on flexion and extension is almost pathognomonic of a torn meniscus.

The most characteristic feature of a recurrent lesion of a semilunar cartilage is the history of one or more attacks of true mechanical locking, which may be momentary or last until reduced by manipulation, which often occurs with an audible snap. Very frequently, mechanical locking occurs at the original accident, and afterwards attacks of sudden giving-way, associated with a loud report, crack, or snap, rather than

true locking. On the other hand, locking may not occur at first, but on subsequent occasions. A patient, in whose knee-joint the author found tears of both semilunars, told him that any turning movement caused a double report "like a double-barrelled gun," and down he fell.

One of the most striking features in differential diagnosis is the excellent and often detailed history that the patient may give. He or she will even demonstrate the exact position of the limb which produces the "locking."

The author has frequently felt justified in exploring a knee-joint solely on such an accurate and careful history, and in the complete absence of any physical signs, and has frequently found in such cases a torn cartilage.

True mechanical locking must, of course, be very carefully distinguished from limitation of movement due to synovial effusion and pain, and from other forms of mechanical locking, as may occur with loose body or certain injuries to the tibial spine.

In some cases the symptoms of semilunar derangement are less typical. For instance, it is obvious that if merely a slight tear is present, this will not bring about true locking, and the symptoms will approximate more to those of sprain of the corresponding lateral ligament, and often there will be a complaint of giving way rather than of true locking. In the author's opinion, it is impossible to diagnose this type from sprain, and it should be treated as the latter at first. Suspicion should be aroused if the symptoms of the sprain persist over an unusually long period, when no limitation of movement suggesting adhesions is present, when all other causes have been excluded (a radiogram being never omitted), and when manipulation followed by a course of re-education of the wasted muscles fails to cure the condition. In such a case exploratory arthrotomy is certainly justifiable.

To sum up, our sheet-anchor in diagnosis between sprain of the deep fibres of the lateral ligament alone and a lesion of the corresponding meniscus must be an accurate and pains-taking history. The position of maximum tenderness helps in some cases, but is often fallacious. There is a type of case

in which, in the present state of our knowledge, having ruled out of court by a complete investigation other forms of internal derangement, it is impossible to say whether a patient is suffering from the sequelæ of a sprain or whether he has one of the less common types of lesion of the internal meniscus.

The practitioner should proceed upon the following lines in this difficult type of case: He should explain the position to his patient and advise a manipulation first, for this is simple, free from risk, and often succeeds. In the event of failure, exploratory operation should then be advised.

Underlying Pathology of Manipulation in Lesions of the Semilunar Cartilages.

It may be stated that just as manipulation in cases of neglected sprain or contusion associated with adhesions is a most valuable therapeutic measure, so is this method of treatment of value in certain recurrent lesions of the semilunar cartilages, even those of long standing. It is necessary to be cautious in using the word "cure," but many cases of apparent cure occur, or cases remain free from symptoms for several years, provided manipulation is properly performed. Removal of the torn and displaced meniscus is, in skilled hands, such a satisfactory procedure that it is the operation of election in most cases. When removal is declined or contra-indicated, trial may be made of manipulation. If the patient's pursuits are strenuous, relapse is common, and removal should be advised.

A fact of fundamental importance in this connection is that the commonest lesion of a semilunar cartilage is, as we have seen, the complete longitudinal tear or "bucket-handle" type of lesion (Figs. 7 and 8), and the characteristic symptoms of the semilunar derangement are due to the behaviour of the fractured portion of cartilage. It is most important to remember that it is quite possible for the inner torn portion, if narrow, to occupy certain abnormal positions without giving rise to any **permanent** "locking" or limitation of movement, or, indeed, to any physical signs whatsoever. For instance, the inner

portion may be in the intercondylar space between the crucial ligament and the femoral condyle, and some sudden turning movement may cause the portion of cartilage to slip outwards and give rise to a temporary or even momentary locking.

If, however, the inner portion is broad, it cannot be in such a position without causing mechanical interference with extension. These facts have all been confirmed on several occasions at operations by the author. This frequent absence of mechanical interference with movement, even when a

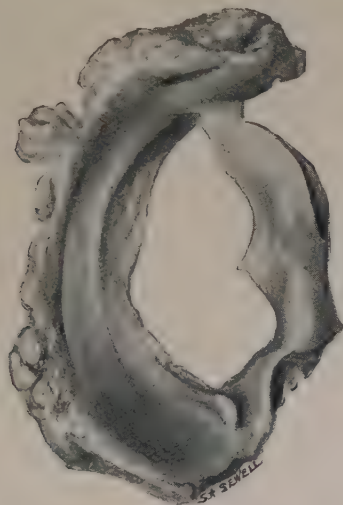


FIG. 7.—TYPICAL "BUCKET-HANDLE" LESION OF INTERNAL SEMILUNAR CARTILAGE.

fractured portion of a semilunar occupies some abnormal position, has hitherto been largely overlooked. It seems fairly clear that by manipulation in this type of case **the displaced fragment is made to retrace its steps**, when in a certain proportion of cases sufficient repair may take place between the two fragments to prevent recurrence. The chances of repair must clearly depend upon the age of the lesion (Figs. 9 and 10). In time the fractured surfaces become smooth and rounded, and in these late cases, the chances of repair are proportionately lessened. Again, in cases of

multiple tear, the chances of permanent recovery by manipulation are very slight.

The author's operation findings, moreover, convince him that in certain cases in which manipulation has been performed, the fractured portion of the cartilage has been forced still further into the region between the femoral condyle and crucial ligament, where from its position it may be less likely to give rise to symptoms than before.

At the risk of recapitulation, this important matter may be summarised as follows: The commonest lesion of a semi-

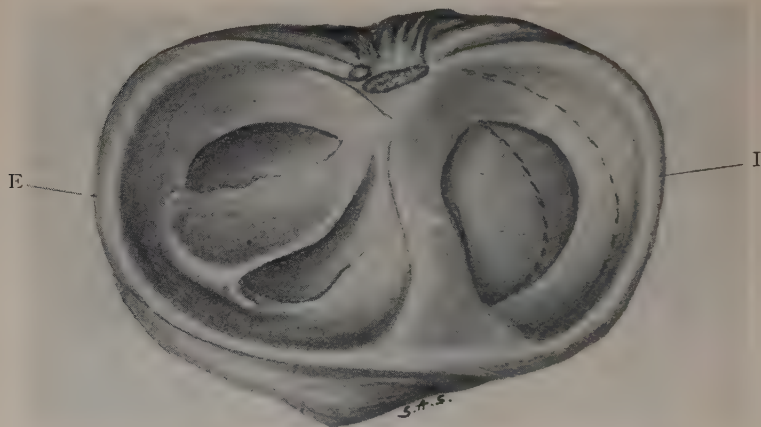


FIG. 8.

A complete longitudinal tear of the internal semilunar cartilage (I) is present, the outer fragment (H) lying in the intercondylar region. A longitudinal tear of the posterior half of the external semilunar cartilage (E) is present, the inner fragment of which occupies an intermediate position. For history see text.

lunar cartilage is the complete longitudinal tear or bucket-handle type. At the original accident the inner torn portion is usually dislocated into the interior of the joint, where it at first, being fixed between the femoral and tibial condyles, gives rise to a mechanical block to extension.

By manipulation two things may happen:

1. The displaced portion may retrace its steps, and provided rotatory movements are avoided for some time, repair will probably take place if performed within a reasonable period.

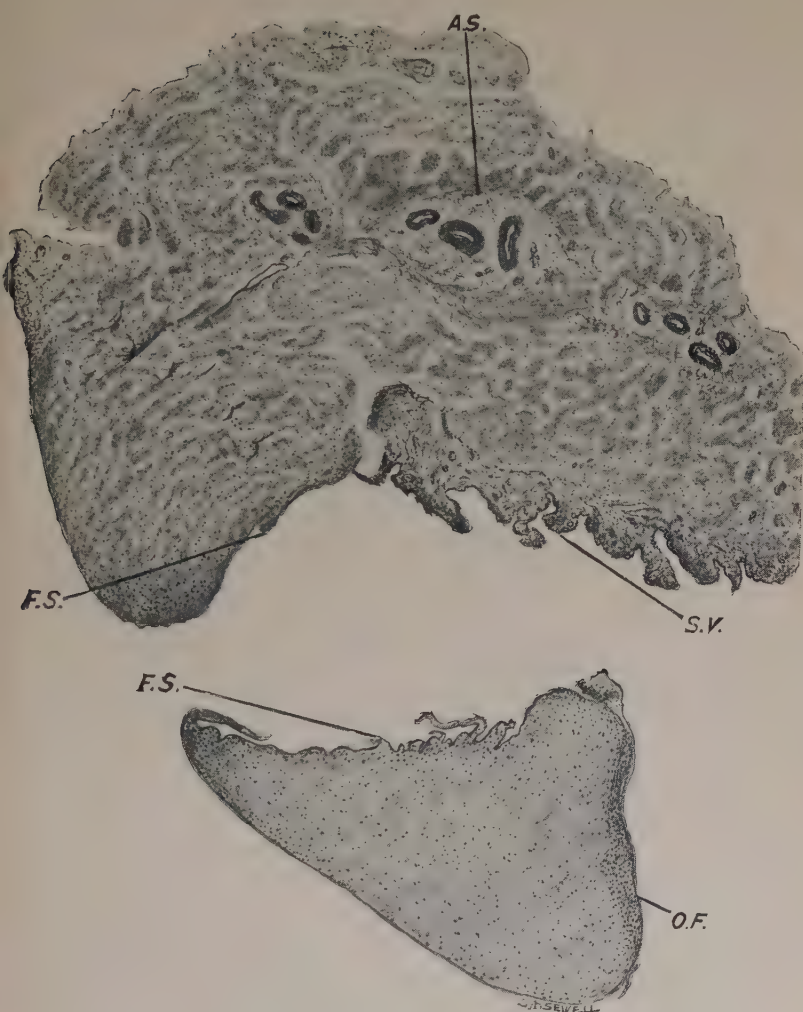


FIG. 9.—TRANSVERSE SECTION OF BOTH PORTIONS OF A BUCKET-HANDLE LESION OF THE INTERNAL SEMILUNAR CARTILAGE.

A.S. = Attached surface of inner fragment.

O.F. = Outer fragment.

S.V. = Synovial villi.

F.S. = Fractured surfaces. Repair is far more advanced in that of the more vascular inner fragment. In the fractured surface of the outer fragment there is very little attempt at repair.

2. The displaced portion may be forced still further into the interior of the joint. Repair between the torn fragments is impossible in this position, but there may be an absence of symptoms for a considerable period.

In recurrent cases the fractured portion may yet be made to retrace its steps by manipulation, but the chances of repair steadily diminish. In cases of long-standing it is extremely doubtful whether it ever completely occurs.

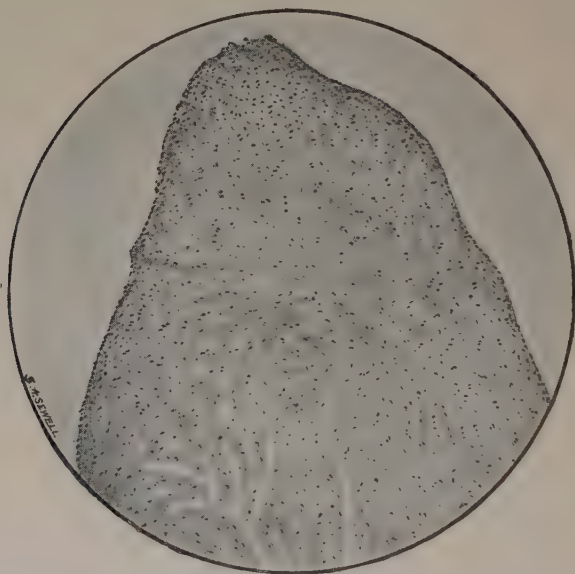


FIG. 10.—FRACTURED SURFACE OF INTERNAL SEMILUNAR CARTILAGE OF LONG-STANDING, SHOWING SMOOTH ENDOTHELIALISED SURFACE.

CASE.—Mrs. L., aged 50, complained of frequent "giving way" with occasional mechanical "locking" of her left knee, the last occasion being a month previously. She presented the classical history, signs and symptoms of a torn internal semilunar cartilage of long-standing, with recurring displacement. These symptoms had been present for no less than thirty-seven years. Each attack of "locking" was followed by marked pain and swelling which necessitated her lying up for three or four weeks at a time. Apparatus had been worn in vain. Her medical advisers either diagnosed the condition correctly, but advised

against operative removal owing to the risk of a stiff joint (sic), or treated her for arthritis. A consulting physician had her teeth X rayed, and several diseased teeth were extracted. An organism was isolated from the gums, and a course of vaccines was administered. The X rays showed slight traumatic osteo-arthritis. This unfortunate lady might have been spared many years of suffering and crippledom by removal of the offending meniscus. The patient was now averse to open operation, but as she was anxious that something should be done to prevent the frequent "giving way" and locking, it was decided to have recourse to manipulation. Manipulation was accordingly successfully performed under gas, particular attention being paid to the "screw-home" movement at the end of extension.

Some Further Conditions of Semilunar Cartilage and Pad Amenable to Manipulation.

There is a group of conditions that interfere with the normal "screw-home" movement of the inner femoral condyle, and which are particularly amenable to treatment by manipulation. These are:

(a) Minor displacements of the anterior half of the internal semilunar cartilage due to stretching or tearing of the coronary attachment.

(b) Inflammatory induration of the semilunar process of the infrapatellar pad of fat (semilunar pad), with adhesions in connection with the latter process.

(a) **Minor Displacements of the Anterior Horn of the Internal Semilunar.**—To refer briefly to the anatomy of this important region. If a transverse section be made through the knee-joint at the level of the semilunar cartilages, it will be seen that the internal semilunar, in addition to the attachment to the true capsule, is firmly adherent to the deep fibres of the internal lateral ligament, and behind this to the aponeurotic layer. The anterior half of the cartilage, however, is separated from the aponeurotic layer by a well-marked interval filled with loose fatty tissue, and the periphery is attached to the margin of the internal tibial condyle by a portion of the true capsule, known as the coronary ligament. A weak mechani-

cal site therefore exists at the spot where the mobile anterior half meets the more fixed posterior half, opposite the level of the internal lateral ligament. A sudden twist inwards of the femur upon the fixed tibia with the knee slightly flexed may, without causing a definite tear of the cartilage or of its anterior attachment, cause a partial rupture of the coronary attachment and a minor displacement not sufficient to cause obvious locking, but a feeling of discomfort on full extension, which may be limited by a few degrees.

(b) **The Semilunar Extensions of the Infrapatellar Pad of Fat.**—In the investigation of 100 formalin-hardened knee-joints the author found that the anterior third of the internal semilunar cartilage was usually protected by a process of the infrapatellar pad of fat, upon which the important screw-home movement of the internal femoral condyle occurs at the termination of extension, and this process is frequently injured, either alone or simultaneously with injury to the anterior end of the internal semilunar. Although the process is so important clinically, it has not been considered worthy of a name, although it is often wrongly called the inner alar pad. Possibly "semilunar process" or "pad" might be a better name. In a large number of cases in which it is considered that a lesion of the cartilage is present, it is really this process which is at fault. A lesion of the process may be followed by the formation of adhesions between it and the cartilage, or some other adjacent structure.

It seems clear that in this group of conditions manipulation is a valuable therapeutic measure.

We must never overlook another very important fact before deciding that any case has been cured by manipulation—viz., that long intervals, which in some cases may amount to many years, may normally exist between attacks of "locking," and, therefore, we can never be logically certain that we have really effected a permanent *cure* in any given case.

If definite recurrence occurs after manipulation, open operation should in most cases be advised, although occasionally a second manipulation may succeed.

It may not be out of place to mention here, that after

operative removal of a semilunar cartilage, very early movements should be instituted. In the author's practice the patient usually walks almost normally by the fourteenth, and in many cases by the tenth, or even seventh day. It is strange to read in the latest edition of a well-known textbook of surgery that after operation, "fixation for two or three weeks should follow, after which massage and passive manipulations are begun."

Illustrative Cases of Semilunar Lesion.—It is not proposed in this work to discuss the surgery of the semilunar cartilages, except in so far as the question of manipulation in recurrent cases is concerned.

Some of the most important points in the clinical history of derangements due to lesions of the semilunar cartilages are well exemplified by the following case, chosen from a series in which tears of the external and internal cartilages were present in the same joint:

CASE I.—A young lady while playing lacrosse turned suddenly and twisted her right knee. She stated that this was accompanied by a "snap" on the inner side of the joint. She was unable to continue playing, and the joint became swollen almost immediately. There was apparently no mechanical locking on this occasion. The joint was treated by rest and compression for three weeks, and the swelling almost entirely subsided. One month later, the knee gave way again on the inner side without locking or swelling.

She consulted a bone-setter, who performed manipulation. She was free from trouble for six months, when one day, while dancing, the knee gave way **on the outer side**, with definite mechanical locking. She again consulted the above-mentioned bone-setter, who restored the joint to free movement. Thereafter, however, the joint frequently gave way on the outer side after any twisting movement, often with true mechanical locking, which, however, was of short duration. This happened several times daily. The inner side of the joint, after the second manipulation, gave rise to no further trouble. She wore for some time various kneecaps and mechanical supports, which, however, were useless.

At operation the condition was found which is represented in Fig. 8.

A complete longitudinal tear of the internal semilunar cartilage is present, the outer portion of which is actually

situated in the intercondylar region. A longitudinal tear of the posterior half of the external semilunar cartilage is present, the inner part of which occupies an intermediate position.

It seems clear that the second manipulation by the bone-setter forced the fractured portion of the internal cartilage towards the interior of the joint.

The intermediate position of the fractured portion of the external semilunar was clearly the cause of the frequent "giving-way" upon the outer side of the joint.

CASE II.—L. W., aged 26, was sent to the author with the following history: Eight weeks previously he severely twisted the left knee, the thigh being rotated forcibly inwards upon the leg, which was slightly flexed and abducted. He experienced severe pain upon the inner side of the joint, and fell. Definite mechanical locking occurred, which was replaced by manipulation. He now stated that the knee frequently gave way and caused him to fall, but no true locking occurred. The knee had remained slightly swollen, but each attack of giving-way had been followed by increased swelling.

On Examination.—Synovial effusion was present, and tenderness over anterior part and middle of inner border of internal semilunar cartilage, and over inner border of tibia immediately to the inner side of the patellar ligament. Movements were full, there being no limitation whatsoever of full extension. Definite wasting of the quadriceps was present.

At operation a typical complete longitudinal tear of the internal meniscus was found to be present, **with the outer fragment lying in the interior of the joint** between the crucial ligament and the inner femoral condyle.

In this case it is quite clear that the original manipulation had driven the fractured portion still further into the interior of the joint, where, although the locking was undone, it gave rise to prolonged disability.

CASE III.—H. F., aged 42, a dock worker, struck the inner side of his left knee against the hand-rail of a barge.

The knee swelled up almost immediately, and was locked with a mechanical block to full extension. The displacement was reduced at a hospital, and he was treated for a few weeks with rest, compression bandage, and massage.

Six months later he complained of pain on the inner and back parts of the joint, and recurrent synovial effusions after exercise.

On Examination.—Movements were full. Definite localised tenderness was present over the middle of the inner border of the internal semilunar. Synovial effusion of moderate amount was present, and three-quarters of an inch wasting of the left thigh.

One week later, manipulation was performed, followed by re-education of the thigh muscles.

The improvement that followed was only temporary, and two months later, the author's operation for cases with classical symptoms was performed. A complete longitudinal tear of the internal semilunar was seen to be present, **with the outer portion actually lying in the intercondylar notch** (Fig. 7).

The meniscus was completely removed. Time actually taken over operation from commencing incision to last stitch, ten minutes.

CASE IV.—The particulars of this case were kindly supplied to me by the late Mr. Graeme Anderson. It is of particular interest, since the patient's knee was manipulated three times—once by a surgeon and twice by a well-known bone-setter—before operation was successfully performed by the patella-displacing method.

Pilot Officer A. T., age 20.

History.—March, 1920, twisted left knee playing Rugby, and was in bed eight weeks. History of locking. Later on attempting to play games the knee gave way with subsequent swelling and pain.

August, 1922, marked lateral mobility. Manipulated knee under gas; no improvement.

Went to bone-setter, who manipulated; no improvement.

Repeated (no extra fee); no improvement.

Third offer to manipulate refused.

Admitted Central R.A.F. Hospital, November 24, 1923. No swelling, no tenderness, marked lateral mobility, and wasting of quadriceps.

Operation December 1, 1923. Joint opened by Timbrell Fisher's method. Internal cartilage found detached in anterior part. Whole removed; external cartilage found loose along lateral edge, but attached fore and aft; displaced like a bucket handle underneath external condyle of femur (convexity of bucket handle pointing inwards).

External cartilage removed; no drainage; healed well.

Movements December 14, 1923.

December 29, 1923, free movement at knee, but still lateral mobility.

January 22, 1924, fit for limited flying.

Patient seen in October, 1924.

Full movement of knee; no lateral mobility, no effusion, no pain; has played tennis and squash; asked permission to play hockey and Rugby football. Granted.

Manipulation in Toxic or Infective Synovitis and Chronic Arthritis.

These conditions are very liable to follow any of the above-mentioned injuries of the knee in persons past the meridian of life.

It is not proposed to discuss the pathology of these extremely common and disabling conditions, as the author has previously discussed this aspect in various publications.

The remarks made at the commencement of this book concerning the misapplication of rest, apply with redoubled force to this group of conditions, in which the articular surfaces are but little affected, and the disease is principally situated in the synovial membrane.

The acute or subacute stage is often of comparatively short duration, but leads in most cases to a certain amount of painful limitation of movement due to intra- and peri-articular adhesions.

Unfortunately, the symptoms due to the presence of these adhesions are sometimes mistaken for some progressive disease, and it occasionally happens that the patient receives every conceivable form of treatment and wanders disconsolately from one spa to another with the knee fixed in an uncomfortable and expensive orthopædic apparatus, while the movement for which the joint is clamouring is withheld.

When such a joint is fixed, it is physiologically placed at the greatest disadvantage to combat any smouldering infection that may be present, for the circulation of not only blood, but lymph, and the secretion and absorption of the synovial fluid depend upon regular movement. When complete rest is enjoined, the formation of synovial fluid is very markedly diminished, and the amount of fresh blood bearing phagocytes and antibodies is reduced to a minimum.

One of the principal complaints in this disease is of stiffness and discomfort of the joint after the night's rest, or after sitting still for some time, but which disappears after exercise. Over-exertion is, of course, to be most carefully avoided, but the practice of completely immobilising the joint in such cases

is contrary to the dictates of reason or even of common sense.

Illustrative Cases.—These cases illustrate the unsatisfactory results of immobilisation in orthopædic apparatus, and the good effect of restoration of movement, which in the first case was preceded by massage and exercises, and in the second and third were obtained more rapidly by manipulation under nitrous oxide anæsthesia.

CASE I.—Lady —— fell down some steps in her country house and “sprained her knee.” Very marked bruising and swelling followed. Early massage and passive movements were instituted, and continued for some months. A radiogram taken three months after the injury showed that there had been a vertical split-fracture of the tibial head in the region of the tibial spine. She had been previously treated for a rheumatoid condition of both knees. Considerable swelling, weakness, and limitation of movement persisted, and she was ordered a celluloid splint to limit movement. This she found uncomfortable, and discarded, as pain and discomfort were increased by immobility.

On examination, one year after the accident, considerable synovial effusion was present, with a certain amount of thickening of the joint capsule. Flexion was limited by some fifteen degrees and painful, extension was full, and there was no lateral mobility. Slight swelling of the leg and ankle were present. The X ray did not reveal any evidence of involvement of the articular surfaces.

This was considered a case of traumatic synovitis upon which a toxic element had become superadded.

It was decided that an attempt should first be made by special exercises and passive manipulation preceded by radiant heat to increase the range of flexion. Later, by manipulation under gas, full flexion was obtained, and there was a marked improvement in the condition of the joint.

CASE II.—Major —— severely injured right knee in India through being run over by a gun-team. Marked swelling followed, which gradually subsided, and he resumed all his usual activities.

Four years later he began to notice recurrent attacks of painful swelling of the joint. He consulted a doctor, who informed him that he had “rheumatoid arthritis.” He was ordered a leather orthopædic apparatus, which kept the knee rigidly extended. Under this treatment the pain became worse.

On Examination.—A typical condition of villous synovitis was found to be present, with painful limitation of full flexion. X ray showed evidence of an old injury to the tibial tubercle, but no involvement of the articular surfaces. A diagnosis of toxic synovitis supervening upon an old injury of the joint was made.

Manipulation was performed with satisfactory results. Pain and limitation of movement disappeared, and he was able to play games without any ill-effects.

He wrote: "My knee is progressing splendidly. I can bend it to an acute angle without pain or difficulty. I have gained a new lease of life."

CASE III.—Miss P., aged 23, a children's nurse. Complained of pain and stiffness of the right knee of nine months' duration. She walked with a marked limp and complained of weakness of the limb. Eighteen months previously she had suffered from acute brachial neuritis, which persisted for many weeks. Nine months before being sent to the author for treatment, she developed an arthritis of the right knee of the rheumatoid type, for which she was treated for three months at a well-known Spa. X rays showed no abnormality; occasional evening temperature occurred. In addition to various forms of treatment by vaccines, drugs, etc., the limb had been immobilised for the greater part of the time by means of a splint.

On Examination.—The right knee presented swelling, due to thickening of synovial membrane and to periarticular changes. Movement within a limited range was painless, but beyond this point was restricted and painful. Generalised tenderness of the joint was present, but the joint surface was cool. A moderate degree of wasting of the right thigh was present.

The case was clearly one of monarticular subacute infective arthritis, in which the infection had "burnt itself out," but left a joint crippled by adhesions.

Manipulation of the joint was performed under gas anæsthesia and full movement obtained without difficulty. Many adhesions were heard to rupture during the procedure. Radiant heat, massage, and graduated exercises were instituted immediately and carried out daily. No pain or increased swelling followed the manipulation. A fortnight later she was walking without a limp, was free from pain, and had full movement in the knee. The improvement has been steadily maintained.

It is a melancholy reflection that there must be many similar cases which are quite unnecessarily condemned to life-long crippledom.

In chronic arthritis of what the author has designated the chondro-osseous and mixed types (osteo-arthritis and rheumatoid arthritis), in which the articular surfaces are also involved, the principle of preserving movement, if this is possible, should be maintained. In these chronic cases, Nature is endeavouring in a remarkable way to form a new joint, and the patient, if possessed of the necessary determination, can assist the process very materially.

The author has endeavoured to show that a fundamental feature is degeneration of the central poorly-nourished part of the articular cartilage, and proliferation, which is often compensatory, of the lateral better-nourished portions, whereby chondro-osteophytes are formed. Nature makes good the loss of the central part of the articular cartilage by sclerosis and eburnation of the subarticular bone, and the chondro-osteophytes extend the articular surface. If regular movements through complete range are maintained from the first, the following benefits result:

1. Contracture by scar tissue, both intra- and extra-articular, with painful limitation of movement, is prevented.
2. Mechanical obstruction of movement by osteophytes is also prevented.
3. The process of eburnation is materially assisted.
4. Muscle tone is preserved.
5. The nutrition of the joint structures is maintained.

Many persons are able to live active lives when all the evidence points to the fact that the articular cartilage in the affected joint has been largely destroyed.

In cases in which these principles have been neglected, an effort should always be made in the first place to restore full movement by manipulation.

It is often assumed, and this applies particularly to the hip-joint, that if marked osteophytes are present, nothing short of open operation can be of any avail. It is surprising to find in many of these cases that limitation of movement actually due to osteophytes is much less than one would

imagine, and that by manipulation a marked increase of movement may be obtained.

Some surgeons recommend the formation of a fixed joint by excision in this type of case.

In the author's opinion, this should only be performed as a last resource.

A fixed joint is a considerable disability in itself—for instance, an ankylosed hip in good position is usually assessed at 60 or 70 per cent. disablement. Cases occasionally come to notice in which this operation has been performed on young persons, in which perhaps a little more effort might have been made to retain a movable joint.

Arthrodesis and excision have a definite place in the surgical treatment of chronic arthritis, but they should never be lightly undertaken, and may be reserved for cases in which manipulation and other measures to preserve a movable joint have failed, or pain is unusually acute.

CASE I.—Mr. H., aged 65, complained of pain, weakness, and stiffness of the left knee of ten months' duration. The onset was somewhat sudden, acute, and associated with painful synovial effusion, which, however, subsided after treatment by fomentations.

Examination revealed typical osteo-arthritis of the left knee, which was confirmed by X-ray examination. No effusion was present, but flexion was limited by twenty-five and extension by fifteen degrees, and there was a moderate degree of wasting of the thigh muscles. It was considered probable that the osteo-arthritic changes had been present for some considerable time, and that the attack of synovitis had led to the formation of adhesions with resulting restriction of movement. The patient had had the usual medical treatment and a long course of local treatment in the form of radiant heat and ionisation, without any very definite improvement. Manipulation was performed under anæsthesia and full movement obtained. This was immediately followed up by special exercises to maintain the increased range of movement, and improve the condition of the muscles. Ten weeks later, the patient wrote from Scotland: "My knee is quite 90 per cent. better. I can bicycle again in moderation, and I am fishing and *wading*, and it does not seem to do any harm, but rather the knee is all the better for it!"

CASE II.—Miss B., aged 65. Complained of pain, weakness, swelling, and stiffness of the left knee, and walked with a marked limp. She stated that these symptoms had been present for seven years, and had been steadily increasing. She had visited many Spas both in this country and on the Continent without relief.

Examination showed a chronic arthritis of the rheumatoid type with limitation of flexion of the knee by thirty degrees, and a moderate degree of wasting of the thigh muscles. X ray revealed slight involvement of the articular surfaces. Manipulation was performed under gas anæsthesia, and the usual after-treatment followed. Two months later the patient wrote: "I have purposely postponed writing to you before, as I wished to give my knee a real testing time. It is now two months since the manipulation, and I am glad to say that the knee has been behaving very well. I have had no return of pain, stiffness, or swelling, and I walk without any limp; even going downhill is fairly easy, and I go up and down stairs in the normal way."

Manipulation in Functional Disorders of the Knee-Joint.

Although we have placed this group at the end of our list, it is the one pre-eminently in which the most brilliant results can be achieved by attention to the principles that have already been enunciated. It is unnecessary to recapitulate these, and it will suffice to illustrate the treatment of this group by a typical case.

Illustrative Case.—Manipulation of knee, functional type, possibly superimposed upon transient synovitis.

Miss P. S., age 27, while undergoing training as a nurse, noticed pain in the right knee on going upstairs after a long period of duty. This steadily increased, but no swelling was ever noticed. The condition was considered to be of infective origin, the tonsils and also two suspicious teeth were removed, and she was recommended to rest the limb and to wear a back-splint with foot-piece. This was worn for six months, and caused the pain to disappear. At the end of this period she began to get about on crutches, and a few months later a calliper splint was substituted. At about this time pain and slight swelling were noticed in the left knee, and she was recommended to wear a calliper splint for this joint also. The joints were X rayed twice, with negative results.

On Examination—Right Knee.—No swelling, but tenderness over internal femoral condyle, and over middle of inner border

of internal semilunar cartilage. Marked limitation of movement, most of which appeared to be due to reflex muscular spasm. Considerable wasting of thigh muscles.

Left Knee.—Tenderness as above. Slight limitation of flexion only.

The general condition was good, and there was nothing of importance to note in her previous history. There was no affection of any other joint. Manipulation was performed under gas and oxygen anæsthesia, followed by immediate re-education. In the case of the right knee, movement to an angle of 80 degrees was obtained very easily, after which some resistance was encountered owing to adhesions. These yielded with the exercise of a moderate degree of force, and full flexion was obtained. In the case of the left knee, full movement was obtained with great ease, such limitation as was previously present having been obviously due to spasm.

Result.—The patient made a complete and almost immediate recovery. Eight days later she walked five miles without the aid of a stick, and without the slightest subsequent discomfort. In a fortnight, she was playing tennis, and other games without ill-effects.

Manipulative Technique.—(a) First, with the leg fully extended, the patella and infrapatellar pad of fat are to be mobilised. This step should be carried out in every case, and is particularly indicated in cases where the adhesions are at all dense, for if flexion be carried out without preliminary mobilisation of the patella, fracture of the latter or severe injury to some part of the extensor apparatus may occur. The surgeon's thumbs are placed on either side of the patella, and the bone is firmly pushed from side to side and from above downwards, and this process is then repeated over the infrapatellar pad of fat. Adhesions in the region of the latter process are of frequent occurrence, and it is probable that this technique is sufficient to rupture those of a minor nature.

(b) *Flexion and Extension.*—The technique differs according to whether the adhesions are slight or dense. If the former (Fig. 12), the surgeon grasps the patient's knee with one hand and the foot with the other hand. Then, while maintaining firm pressure upon any particular spot of tenderness that is considered to indicate an adhesion, a series of rapid but purposive flexion movements are performed, and often a

definite snap proclaims the rupture of adhesive bands, and full movement is restored. If extension is limited in this type of case the limb is lowered and the surgeon steadily extends by firm pressure with both hands upon the front of the joint, or one hand may grasp the foot while the other exerts counter-pressure upon the front of the lower third of the thigh. In some cases there is interference with the normal "screw-home" movement at the end of extension, and in these particular attention must be paid to the external rotation of the tibia at the termination of extension. Next, rotatory movements are performed in the following manner: The knee is fully flexed and then gradually extended, and during the latter movement a series of quick rotatory movements, both inwards and outwards, are performed. Care must be exercised during the latter movements to avoid the exercise of undue force, as this may cause severe sprain of the lateral ligaments, or even damage to one of the semilunar cartilages.

In cases where the limitation of movement is more obstinate a shorter leverage is utilised, and, needless to say, the greatest of care is exercised. Experience teaches the amount of force that may justifiably be exerted, but this should never be great. If one may use such an expression, a skilled manipulator will, as it were, gradually coax movement back to the erstwhile stiff joint. In this process there is a complete absence of hurry and fussiness. When shall the surgeon stay his hand? The golden rule is, "When in doubt, stop." It is far wiser to rest content with a slight but definite increase of range, to consolidate the position gained by proper after-treatment, and to decide upon a further manipulation later.

As already mentioned, the patella should first be mobilised as much as possible; the surgeon next grasps the patient's knee with one hand and supports the patella, while with the other hand he grasps the patient's leg in the middle or lower third. The thigh is flexed upon the abdomen, and the knee is then gradually flexed by the exercise of steady pressure. The overcoming of limitation to extension is a somewhat more difficult problem, and may be approached in the following manner: A firm sand-bag is placed beneath the lower part

of the patient's leg. The surgeon then exercises downward pressure with both hands upon the front part of the patient's knee, and it may be of advantage if he stands upon a low stool for this stage of the manipulation. Extension of the knee should never be performed with a jerk, as this is liable to damage the anterior attachments of the semilunar cartilages or anterior crucial ligament.

Second Method of Manipulation.—This valuable method, which has been much favoured by generations of bone-setters, is carried out as follows (Fig. 11):

The patient sits or lies with the affected leg bent over the end of the chair or table. The surgeon seats himself, or stands, if necessary, in such a way that the patient's foot is firmly fixed between his thighs, while with both hands he grasps the patient's knee, which he thus steadies and supports. The actual bending of the patient's limb at the knee-joint is performed by the movement of the surgeon's thighs, assisted by his hands, which also control and support the knee-joint. Another advantage of this "grip" is that very powerful rotation can be performed if necessary by lateral inclination of the surgeon's thighs, combined with firm rotatory movement in the same direction of the affected tibia, the head of which is firmly grasped by the surgeon's hands.

After-Treatment.—In cases of minor adhesions the general rule of immediate re-education is followed. Where, however, the stiffness has been of a firmer nature, the immediate after-treatment depends upon whether flexion or extension was the movement previously limited. If the former the knee is temporarily fixed in as fully flexed a position as possible. Massage can be commenced almost at once, and at the end of twenty-four hours, and in some cases a lesser period, movements are instituted. Particular attention is paid to the maintenance of the increased range obtained, and this entails perseverance, patience, and determination on the part of both patient and the person responsible for the after-treatment. When extension has been limited, the same principles of after-treatment are applicable, and the limb is fixed in extension for the same period. In some rather obstinate cases it is a



FIG. I I. -MANIPULATION OF KNEE: METHOD 2.

wise procedure for the patient to have massage, movements, and re-education during the day, and for the limb to be fixed in a retentive apparatus at night to counteract any tendency to recontracture. This applies more frequently to cases in which extension has been limited, but the same principle is applicable to certain cases of limitation of flexion.

Manipulative Technique in Lesions of the Semilunar Cartilages.

We have already discussed the indications for this measure in the treatment of this large group. It remains solely to discuss the manipulative technique. It should be remembered that in the commonest type of lesion the inner side of the joint has been unduly "opened up" during a sudden rotatory movement with the knee partially flexed. The internal semilunar cartilage, having been partially torn from its attachments, slipped towards the interior of the joint, and then, before it could return, was crushed between the inner condyles of the femur and tibia and longitudinally split. The outer torn portion, the so-called "handle of the bucket," usually lies in the intercondylar interval between the crucial ligaments and the outer border of the internal femoral condyle. The inner torn portion lies in contact with the capsule in its usual position, but is probably, owing to the tearing of some of its attachments, abnormally mobile. The problem, therefore, is how to cause the outer torn portion which has become dislocated into the interior of the joint to retrace its steps. In other words our aim must be to bring the two fractured portions into accurate apposition at the earliest possible moment before degenerative changes have occurred therein, and the chances of repair considerably reduced. If manipulative replacement is attempted early, we are assisted by the natural elastic tendency of the displaced portion to spring back into position. Replacement is in some cases extremely easy, and in others, particularly if they have remained long unreduced, a very difficult proposition. An important essential is to obtain complete muscular relaxation, and for this purpose an anæsthetic, such as gas and oxygen, or even gas alone if given by an expert, is usually desirable.

If the cartilage has been displaced for several weeks ether or chloroform may be necessary. A preliminary attempt should certainly be made to reduce without an anæsthetic, as this sometimes succeeds. We should bear in mind that the majority of the bone-setters of the past, many of whom, such as John Hutton, acquired considerable fame, reduced torn and displaced semilunar cartilages without any aid from anæsthesia. The methods they adopted to abolish muscle spasm were in many cases most ingenious. Hutton



FIG. 12.—MANIPULATION OF KNEE FOR FRACTURE-DISLOCATION OF INTERNAL SEMILUNAR CARTILAGE. STAGE 1: FULL FLEXION.

used to say, "It's the twist that does it," and certain it is that by a swift movement of rotation of the flexed knee he rendered the powerful flexors and extensors temporarily powerless, and then, by a rapid movement of extension, induced the torn and displaced cartilage to retrace its steps. Certainly by the use of an anæsthetic the replacement is much facilitated, and the patient spared a considerable amount of pain. The following method usually succeeds, and is therefore recommended (Figs. 12, 13, and 14):



FIG. 13.—STAGE 2: ROTATION COMBINED WITH ABDUCTION.



FIG. 14.—MANIPULATION OF KNEE FOR FRACTURE-DISLOCATION OF INTERNAL SEMILUNAR CARTILAGE. STAGE 3: EXTENSION TERMINATING IN INTERNAL ROTATION.

The patient lies upon a couch. The surgeon grasps the patient's foot with one hand and the knee with the other. He fully flexes the patient's knee, and while abducting as much as possible, thus opening up the inner side of the joint, rapidly rotates the tibia inwards and outwards. In some cases, as soon as relaxation is complete, the mere movement of full flexion causes the displaced fragment to return with an audible snap. In others, this happens during the rapid rotatory movements. In the majority, however, a rapid movement of extension, accompanied by internal rotation of the tibia, is the movement which has the desired result. In some difficult cases the second method of manipulation mentioned on p. 78 will be found of value.

The test of reduction consists in the fact that **the patient can fully extend the knee without pain**. If full extension is restricted by only a few degrees and is painful, it is useless to deceive oneself that the cartilage is reduced. The author desires to emphasise this fact as strongly as possible, as he sees many cases of unreduced cartilages in which the surgeon has solemnly assured the patient that the cartilage was reduced, and has been not a little perturbed when the patient has with equal assurance declared that the cartilage was still "out." A golden rule to remember in these cases is that the patient's feelings are usually a very reliable indication of the success or otherwise of the manipulation, and are by no means to be despised.

After-Treatment.—At one time the author favoured a somewhat long period of rest after reduction in order to permit union to take place. He has, as the result of further experience, come to the conclusion that the results of prolonged rest are far less satisfactory than if massage and movements of the right kind are instituted early. A too rigid observance of the doctrine of rest leads to two very serious complications:

(a) Wasting of the thigh muscles, particularly the quadriceps extensor cruris.

(b) Adhesions.

Furthermore, there appears to be no evidence that the earlier institution of massage and movements, provided those

of a rotatory nature are religiously avoided, does not assist rather than impede the processes of repair in the fractured cartilage.

It is certain that repair in the semilunar menisci is exceedingly slow and sluggish, and it is highly probable that complete repair is a question of months rather than weeks. To immobilise for two or three weeks would therefore appear to be futile, and to attempt immobilisation for the longer period most undesirable, and liable to inflict permanent damage upon the joint. A firm compression bandage is worn until all effusion has subsided, and then gradually abandoned. The inner side of the shoe is raised, and the patient warned not to turn the toes outward. All movement and exercises involving rotation are avoided, and active exercises against resistance and electrical treatment of the thigh muscles instituted as soon as the acute pain and swelling have subsided. In fact, the treatment is somewhat similar to that of a sprain of a lateral ligament.

(b) The Hip-Joint.

Surgical Anatomy (Fig. 15).—This joint is a ball-and-socket joint in which the head of the femur is received into the cup-shaped acetabulum. Unlike that other ball-and-socket joint, the shoulder, its strength depends to a large extent upon the shape and mutual apposition of the articular surfaces, and upon the strength of the capsule and accessory ligaments which surround it. The cup-shaped acetabulum is deepened by the cotyloid and transverse ligaments.

Articular Capsule.—Is strong except in its postero-inferior part. Its proximal attachments are to the rim of the acetabulum above and behind, and to the cotyloid and transverse ligaments in front and below. Its distal attachments are anteriorly to the anterior intertrochanteric line; above and below to the root of the neck at its junction with the great trochanter; and posteriorly to the femoral neck half an inch above the posterior intertrochanteric line. The longitudinal fibres of the capsule are more marked anteriorly and above, while the circular fibres (*zona orbicularis*) are more prominent below and behind.

Accessory Ligaments.—The Y-shaped ligament of Bigelow strengthens the front part of the capsule. It is narrow above where it is attached to the anterior inferior spine of the ilium, and broadens out below where it is attached along the anterior intertrochanteric line.

Pubo-capsular Ligament.—This stretches between the ascending pubic ramus and the lower part of the capsule.



FIG. 15.—CORONAL SECTION OF HIP-JOINT.

Ischio-capsular Ligament.— This stretches between the ischium just below the acetabulum, and blends with the circular fibres at the lower part of the capsule.

The *Retinacula* are capsular strands which are reflected upwards along the femoral neck from the root of the latter to its junction with the femoral head.

The *Ligamentum Teres* is a triangular ligament lying inside

the joint and covered by synovial membrane. It is attached by its apex into a slight depression in the femoral head a little behind and below its centre, and by its base to the transverse ligament and margins of the acetabular notch. It is doubtful whether it plays any useful part, but is tightened by flexion, adduction, and rotation outwards of the hip, as when one leg is crossed over the other in the sitting position.

The *Synovial Membrane* lines the deep surface of the capsule, and is reflected therefrom upon the femoral neck, which it clothes as far as the margin of the head, so that the neck is

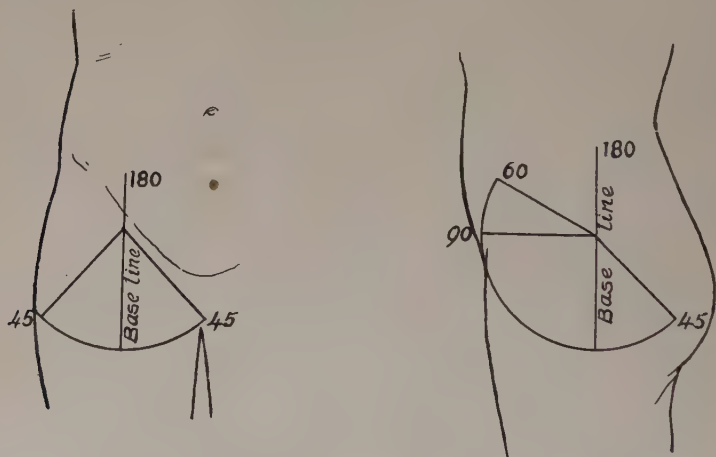


FIG. 16.—DIAGRAMMATIC REPRESENTATION OF RANGE OF HIP MOVEMENT.

contained in a tube of synovial membrane. The membrane also lines both surfaces of the cotyloid ligament, and the surface of the Haversian pad of fat in the floor of the acetabulum, and is prolonged therefrom in the form of a sheath around the ligamentum teres. Occasionally the synovial membrane of the joint communicates with the bursa under the ilio-psoas by an opening between the ilio-femoral and pubo-capsular ligaments.

Movements and Normal Range.—In testing the hip movements, the pelvis must always be steadied to avoid movement of the lumbar spine, which might create a false impression (Fig. 16).

(a) Flexion can be carried out in the sagittal plane, and when the knee is simultaneously flexed, until the soft parts of thigh and abdominal wall come into contact (Fig. 17).



FIG. 17.—MOVEMENTS OF HIP: FLEXION WITH SIMULTANEOUS FLEXION OF KNEE.

It is, therefore, a variable factor. When the knee is extended, owing to the tension of the hamstring muscles, flexion of the hip is only normally possible to an angle of 90 degrees (Fig. 18).

(b) Extension is possible to an angle of about 45 degrees



FIG. 18.—MOVEMENTS OF HIP: FLEXION (WITH KNEE EXTENDED).



FIG. 19.—MOVEMENTS OF HIP: EXTENSION.

beyond the axis of the trunk, and is checked principally by the ilio-femoral ligament (Fig. 19).

(c) Abduction exists to an angle of about 50 degrees, and is checked by the pubo-capsular and inner part of the ilio-femoral ligaments (Fig. 20).

(d) Adduction, when the opposite leg is flexed, is possible to an angle of 45 degrees.



FIG. 20.—MOVEMENTS OF HIP: ABDUCTION.

External rotation, which is much stronger than internal rotation, exists to about 60 degrees, and is then checked by the outer part of the ilio-femoral ligament. Internal rotation, which is checked by the ischio-capsular ligament, exists through about 30 degrees (Figs. 21, 22, and 23).

Manipulation of the Hip-Joint.

The hip-joint, when diseased, causes the thigh to assume at first a position of abduction, flexion, and rotation outwards,

which, from various observations, clinical and experimental, would appear to be the position of greatest ease. In the later stages, owing to the more powerful action of the adductor group of muscles, the thigh becomes adducted and rotated inwards, and flexion becomes somewhat more marked. It is well known that the deformity tends to be obscured in most cases by pelvic and spinal movement. For instance, the



FIG. 21.—MOVEMENTS OF HIP: EXTERNAL ROTATION.

abduction is masked by tilting downwards of the pelvis on the affected side, which causes the lower extremities to remain parallel to each other, resulting in apparent lengthening of the thigh, whereas the flexion is obscured by lordosis of the lumbar spine. Later, when the thigh becomes adducted, the pelvis is elevated on the affected side in order again to make the lower extremities parallel, and apparent shortening

results. The tilting of the pelvis is associated with a compensatory scoliosis of the spine. When actual destructive changes have occurred, true shortening is usually present.

Unfortunately, the natural position that the diseased hip assumes is an unsatisfactory one from the functional point of view. Experience teaches that the best position for ankylosis of the hip is one of extension, with slight abduction and rotation outwards. It is quite common to see in many



FIG. 22.—MOVEMENTS OF HIP: INTERNAL ROTATION.

cases of ankylosis of the hip that the effect upon function is much less than might be expected. The author has encountered a case of a lady with ankylosed hip who is able to dance, and in whom limp is scarcely perceptible.

Causes of Stiffness of the Hip-Joint.—Among the commonest causes of stiffness of the hip-joint amenable to manipulation are fractures of the femoral neck or acetabulum, ligamentous or muscular sprains and contusions which have led to limita-

tion of some particular movement, chronic arthritis in which limitation of all movements of variable extent is usually present, and functional cases.

Manipulation of the hip is often of marked benefit in chronic arthritis, particularly in the more chronic forms associated with lipping.

The benefit often lasts a considerable time, and the manipulation can be repeated if necessary.

In the types of chronic arthritis unassociated with lipping, although marked benefit sometimes results, yet disappoint-

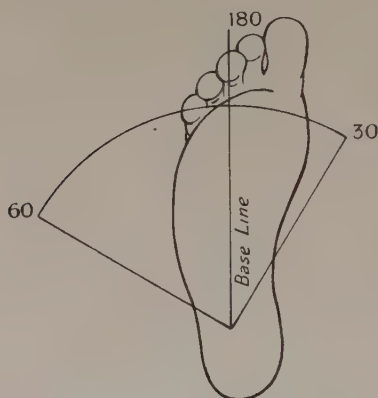


FIG. 23.—ROTATION OF HIP.

ments occur, but the author has not personally met with a case in which the symptoms were made worse by manipulation.

Sprains and contusions are of far less frequent occurrence in the hip than in the knee-joint, owing to anatomical considerations. As we have seen, the strength of the hip-joint depends very largely upon the shape and accurate apposition of the femoral head and the acetabulum, and there is less likelihood of the ligaments being injured except by a somewhat severe form of violence. Scar tissue in the adjacent muscles is, however, of fairly frequent occurrence. For instance, injury to the adductor muscles may lead to painful limitation of abduction, and limitation of extension may follow injury to the muscles in the groin.

Manipulative Technique.—This should be performed upon a somewhat low table or bed which is firmly fixed. It is impossible to manipulate a hip upon a table which is too high or which slips upon the floor of the operating theatre. If the floor of the theatre is highly polished the surgeon should wear rubber shoes to enable a firm purchase to be obtained. In every case the pelvis of the patient should be fixed by an assistant, or by a firm pelvic band, as otherwise the desired movement does not take place at the hip-joint, but in the lumbar spine, owing to movement of the pelvis.

The general rule must be followed concerning the grips—viz., that in cases of somewhat dense adhesions, a short leverage, and in the cases of slighter adhesions, a longer leverage, is utilised. In the former case (Fig. 24) the surgeon grasps the patient's thigh with both hands in the middle third and commences by gently rotating the joint. During this movement traction should be exerted to endeavour to minimise friction between the femoral head and the acetabulum. The remaining movements are then carefully and slowly performed, taking care not to exercise undue force, and finishing with circumduction. Flexion is, as a rule, fairly easily obtained. The recovery of full abduction is a somewhat more difficult problem, owing to the powerful contracture of the adductor muscles. If, when the patient is fully under the influence of the anæsthetic, the tendon of the adductor longus can still be felt as a hard resistant structure, an attempt may first be made to remedy this by firm kneading and by rapid blows administered with the ulnar border of the hand. If this is ineffectual, it may be assumed that the shortening is of the fixed type, and subcutaneous tenotomy of the adductor longus tendon may be performed with advantage. In cases where the contracture of the adductor is marked and fixed, open division is often a satisfactory procedure, followed by manipulation. Similarly, in cases of marked flexion deformity, open division of contracted structures may be necessary. In performing extension, the patient should be rolled over upon his side. Here, as in the manipulation of every joint, the normal range of movement must be most carefully borne

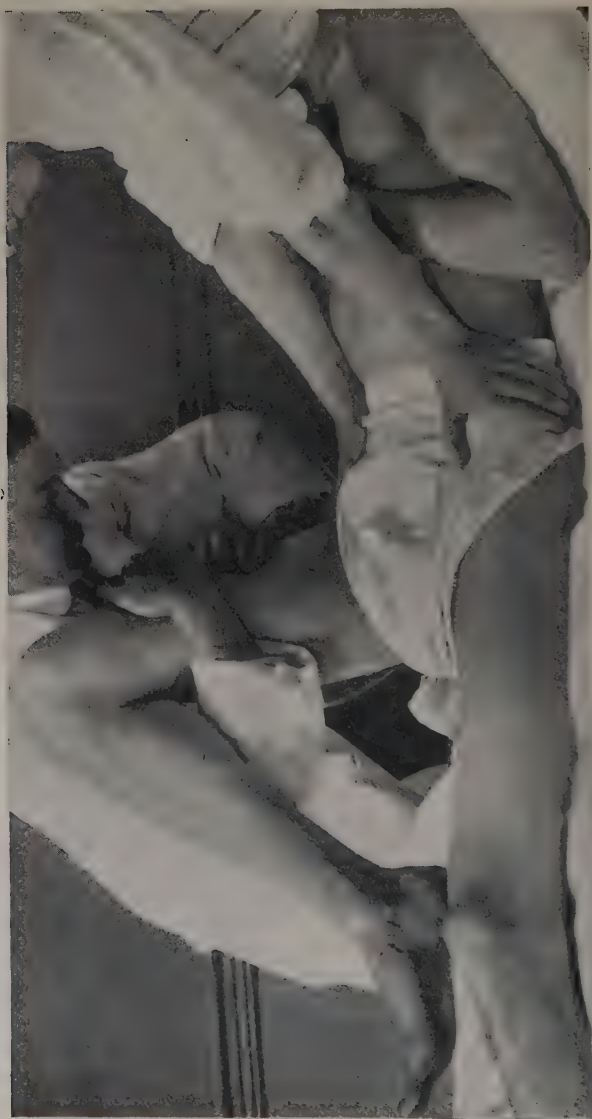


FIG. 24.—MANIPULATION OF HIP. METHOD 1: SHORT LEVERAGE.

in mind, as if an attempt is made to exceed this movement, injury will probably be inflicted upon ligamentous, tendinous, or muscular fibres. In minor degrees of stiffness (Fig. 25) the surgeon grasps the lower end of the thigh in the region of the knee-joint with one hand and steadies the pelvis with the other. The after-treatment is as follows:

In minor cases of stiffness, and particularly in functional cases, re-education commences immediately; indeed, in most cases before the patient leaves the operating table. For this reason gas and oxygen anæsthesia, which produces in skilled hands perfectly adequate relaxation, and from which the patient as a rule recovers rapidly, is a most valuable anæsthetic for this type of case. In more severe cases, the after-treatment adopted is as follows: The patient returns to bed, and the limb is fully abducted by means of sand-bags. To prevent tilting of the pelvis, the opposite limb should also be fully abducted. If pain is marked, an injection of morphia is usually advisable. He lies thus for twenty-four hours, and receives massage for the whole limb. At the end of this period the limb is carefully adducted and put through its full range of movement, at the end of which it is fully abducted again. At the end of a week, it should be possible for the patient to move the limb actively through the increased range of movement. He is then allowed to get up and perform various exercises, at first assistive, followed later by those of a resistive nature. The movement of abduction is one to which particular attention should be paid.

One can scarcely sufficiently condemn the frequent practice of manipulation followed by fixation in plaster, if the object is to obtain an increased range of movement. A most important essential is to enlist the support of the patient's muscles in maintaining the increased range of movement. When fixed in plaster, the muscles waste with great rapidity, and the joint tends to stiffen in the new position. The "splints and plaster brigade," which is so much in evidence in our profession, might with advantage learn a lesson in this respect from the most successful of the bone-setters, who religiously avoid plaster. Who shall say that this avoidance



FIG. 25. —MANIPULATION OF HIP. METHOD 2: LONG LEVERAGE.

is not based upon sound, though possibly instinctive, physiological and pathological principles?

When the patient has thus undergone a course of exercises under special supervision, he is carefully warned to observe the following principle thereafter—viz., that the joint is to be put through its full range of movement daily to prevent any tendency to recontracture, particularly in those cases following arthritis. To attain this end, the patient is instructed in a few simple exercises, and told that these are to be performed for a few minutes morning and evening. It is the practice of some surgeons after manipulation of the hip to order the wearing of an orthopædic apparatus, such as a Thomas's calliper splint or modifications thereof, the object being to maintain extension during walking and weight-bearing for awhile. In the author's opinion, this measure is only indicated in those cases where there is evidence that painful pressure exists between the articular surfaces, as in types of chronic arthritis associated with the growth of synovial pannus over the articular surfaces. In the more chronic forms of arthritis, and in the so-called osteo-arthritis, pain is but rarely due to this cause, and a certain amount of weight-bearing is actually desirable to bring about that sclerosis and eburnation of the articular surfaces which is Nature's method of cure.

Illustrative Cases.—

CASE I.—B., aged 42. Pain in left hip-joint for five years, with increasing weakness and stiffness. The pain was more marked after exercise, and the stiffness more apparent during the early period of the day. No history of previous illness, and general condition otherwise good.

On Examination.—All movements of the left hip-joint slightly restricted, particularly abduction. Definite wasting of glutei and thigh muscles on affected side. X ray revealed slight but definite osteo-arthritic changes, with lipping of the acetabular margin, but no evidence of gross absorption of articular cartilage. It was clear that the limitation of movement present was not due to the osteophytic development, but to scar tissue.

Under a general anæsthetic, manipulation was performed. Full movement was obtained with the employment of a

moderate degree of force only. The patient was returned to bed, and the affected limb maintained in the fully abducted position with sand-bags, and to prevent tilting of the pelvis, the opposite limb was similarly placed. The following day the limb was massaged, carefully put through its full range of movement, and at the end of the session again fully abducted. This procedure was continued for a week. At the end of this time the patient was allowed to get up, and commenced more strenuous exercise. It was now found that voluntary movements through complete range were perfect and painless, and they have thus remained, and the patient has been able to play tennis and other games without discomfort.

The *rationale* underlying the treatment in this case may be shortly summarised as follows:

It is probable that, owing to some transient infective or toxic condition, a degeneration of the central part of the articular surfaces occurred. This was followed by compensatory lipping and scarring of the joint capsule. The infective condition disappeared, but symptoms persisted, owing to the presence of the scar tissue. The slight limitation of movement also prevented the natural cure of the joint condition by eburnation and sclerosis, and a vicious circle resulted. The vicious circle was broken by manipulation, and subsequent contracture prevented by careful and painstaking after-treatment. The prognosis in such a case is good provided regular movement through complete range is continued, particularly as careful search failed to reveal any focus of toxic absorption.

CASE II.—Male, aged 43. Slight osteo-arthritis of hip, with large functional element. Hip-joint had been immobilised by splints and plaster for five years. All active movements of hip markedly restricted, but on examination under anæsthetic, actual limitation of movement proved to be but slight, although somewhat deep anæsthesia was necessary to entirely abolish muscular spasm.

The hip-joint was manipulated and full movement obtained. The patient was kept in bed for twenty-four hours with the affected limb fully abducted, after which active exercises with re-education were immediately instituted. Five months later, the patient returned to his work, walking without a limp and without the use of a stick. Full movement of the hip was present, and his improvement has been maintained.

CASE III.—Mrs. T., aged 68. Complained of marked pain and stiffness of both hips rendering walking impossible. Both pain and stiffness had been present for several years, had been steadily increasing, and after an attack of bronchitis during the previous winter, had rapidly become more marked.

The patient travelled up from the provinces upon a stretcher. X-ray examination revealed well-marked osteo-arthritis of both hips, with lipping of the femoral heads and acetabular margins. All movements of both hips were markedly restricted, partly from organic causes, and partly from muscular spasm. Some flexion deformity of the left thigh was present.

Treatment.—After preliminary injection of scopolamine and morphine, gas and oxygen were carefully administered, and manipulation of the hip-joints performed. A marked increase of range of movement resulted. Both thighs were left abducted as fully as possible for twenty-four hours, during which time massage was given. At the end of this period, active and passive movements were instituted, and continued regularly.

There was a very marked improvement in the patient's condition when she left the nursing home ten days later. The increased range of movement had been maintained, and whereas she was carried in on a stretcher, before leaving she demonstrated her ability to walk well and to negotiate stairs. Eighteen months later, a report stated "her walking powers are much increased, and she now goes about the house, up and down stairs, with the aid of only one stick." The improvement has since been maintained.

CASE IV.—T., aged 56. Complained of stiffness of both hips, more marked in the left hip, associated with pain, particularly on the inner aspect of the thigh in the adductor region.

He stated that the trouble started about three years before, and had steadily progressed in spite of many forms of treatment, including the removal of all teeth.

On Examination.—All movements of both hips were restricted 50 per cent.

The X ray showed typical osteo-arthritic changes, rather more advanced on the left side.

Manipulation of both hips was performed under gas and oxygen anæsthesia with gratifying results.

(c) The Ankle-Joint.

Surgical Anatomy (Figs. 26 and 27).—A hinge-joint in which the lower articular surface of the tibia with the outer surface of its internal malleolus and the inner surface of the external

malleolus of the fibula articulate with the upper and lateral surfaces of the astragalus. The upper articular surface of the astragalus is broader in front than behind.

The *Capsular Ligament* is a fibrous membrane varying in strength, which is strengthened at certain spots by accessory ligaments. It is attached above to the margins of the articular



FIG. 26.—CORONAL SECTION OF ANKLE AND ASTRAGALO-CALCANEAN JOINTS.

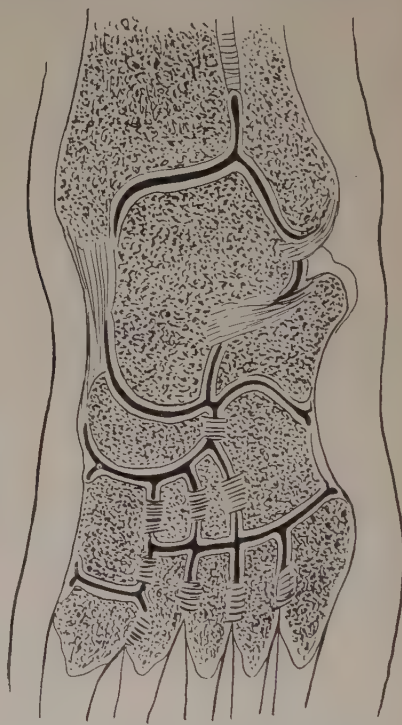


FIG. 27.—CORONAL SECTION OF FOOT TO DEMONSTRATE SYNOVIAL CAVITIES.

surface of the tibia, and below to the astragalus around its upper articular surface.

The *Anterior Ligament* is attached above to the anterior margin of the lower end of the tibia, and below to the upper surface of the neck of the astragalus just in front of the articular surface.

The *Posterior Ligament* is attached above to the posterior margin of the lower end of the tibia, to the inferior transverse tibio-fibular ligament, and to the pit on the inner surface of the external malleolus; and below to the upper surface of the body of the astragalus behind the upper articular facet.

The *Internal Lateral* or *Deltoid Ligament* is triangular in shape, and attached above to the apex and anterior and posterior borders of the internal malleolus. The superficial fibres are attached from before backwards into the tuberosity of the scaphoid, the inner margin of the inferior calcaneo-scaphoid ("spring") ligament, the sustentaculum tali of the os calcis, the inner surface of the astragalus, and the tubercle on its posterior surface. The deep fibres are attached above to the tip of the internal malleolus, and below to the inner surface of the astragalus.

The *External Lateral Ligament* consists of three well-marked fasciculi separated by weaker portions of the capsule. The anterior fasciculus passes from the anterior margin of the external malleolus near its tip, to the outer surface of the neck of the astragalus. The middle fasciculus passes from the apex of the external malleolus to a tubercle on the outer surface of the os calcis. The posterior fasciculus is almost horizontal, and passes inwards and slightly backwards from the pit on the inner surface of the external malleolus, to the posterior surface of the astragalus external to the groove for the flexor longus hallucis.

Synovial Membrane.—Lines the deep surface of the capsule, and is reflected to the margins of the articular cartilage. It sends a process upwards between the lower ends of the tibia and fibula.

Surgical Anatomy of the Peri-articular Tendons of the Ankle, with their Synovial Sheaths—*Anterior Aspect*.—The anterior annular ligament, a well-defined condensation of the deep fascia, is divided into two distinct portions. The upper is a transverse band attached externally to the fibula and internally to the tibia slightly above the level of the ankle-joint. Beneath it the extensor tendons pass, the tendon of the tibialis anticus being surrounded by a separate synovial sheath. The

lower portion of the anterior annular ligament is Y-shaped, and is situated over the joint interval. The narrow outer portion is attached to the outer part of the os calcis, while internally the upper divergent band is attached to the internal malleolus, and the lower band blends with the deep fascia on the inner aspect of the foot. The synovial compartments beneath this Y-shaped portion of the anterior annular ligament should be carefully noted, and are of great practical importance.

The innermost tendon, that of the tibialis anticus, passes through both limbs of the Y-shaped portion, and receives a sheath of synovial membrane at each spot. External to this tendon, the tendon of the extensor longus hallucis behaves in a similar fashion. Still more external, the tendons of the extensor longus digitorum and extensor brevis digitorum pass through the apex of this portion of the annular ligament surrounded by synovial sheaths.

Internal Aspect.—The *internal annular ligament* bridges over the interval between the internal malleolus and the prominence of the os calcis. Septa pass between its deep surface and the bone, and separate the interval into compartments for the tendons, vessels, and nerve, which are disposed as follows from within outwards:

1. Tendon of tibialis posticus.
2. Tendon of flexor longus digitorum.
3. Posterior tibial vessels and nerve.
4. Tendon of flexor longus hallucis.

Each of the tendons is covered by a synovial layer, which lines also the sheath which surrounds it.

External Aspect: The External Annular Ligament.—The peronei tendons are held in place in the hollow between the external malleolus and the prominence of the os calcis by the above-mentioned ligament, and are surrounded at this spot by a common synovial sheath. Having emerged from beneath the ligament, the tendons diverge on the outer surface of the os calcis. The tendon of the peroneus brevis passes above and the tendon of the peroneus longus passes below the peroneal tubercle on the outer surface of the os calcis, each tendon being surrounded by an extension from the common synovial sheath.

Posterior Aspect : Tendo Achillis.—This tendon narrows as it descends, but expands somewhat at its termination. It is inserted into the middle of the posterior surface of the os calcis. A synovial bursa separates the tendon from the upper part of the posterior surface of the os calcis.

Movements (Fig. 28).—The normal weight-bearing position of the foot is when it forms an angle of 90 degrees with the leg. In flexion or dorsiflexion (Fig. 29) the foot moves upwards at the ankle-joint and forms a more acute angle with the leg. Extension or plantar flexion (Fig. 30) is the opposite movement, in which the toes are pointed downwards and the foot forms an obtuse angle with the leg. To avoid confusion, it should

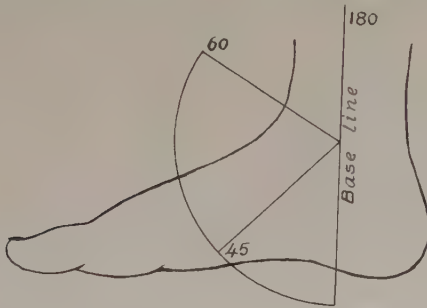


FIG. 28.—RANGE OF ANKLE MOVEMENTS.

To avoid confusion, it should be noted that in extreme dorsiflexion the foot forms an angle of 60 degrees with the base line, but that the foot moves through 30 degrees from the neutral position.

be remembered that dorsiflexion at the ankle is produced not only by the tibialis anticus and peroneus tertius, but by the extensors of the toes—viz., extensor longus digitorum and extensor longus hallucis. Similarly, extension at the ankle or plantar flexion (*i.e.*, pointing the toes) is produced by the gastrocnemius, soleus, tibialis posticus, peronei longus and brevis, plantaris, and the **flexors** of the toes—viz., flexor longus digitorum and flexor longus hallucis.

The actual range of movement at the ankle-joint varies within considerable limits in different normal individuals, and depends largely upon the position of the knee. When the knee is extended, as in the normal weight-bearing position,

it is unusual for more than 15 or 20 degrees of dorsiflexion to be possible, and in some individuals, this can only be obtained by slightly everting and abducting the foot. Extension of the foot at the ankle-joint is usually possible through 45 or 50 degrees beyond the right angle—*i.e.*, until the foot makes an angle of 135 or 140 degrees with the leg. Another very important and often overlooked fact to be borne in mind is that the axis of the astragalus is slightly oblique, and that



FIG. 29.—MOVEMENTS OF ANKLE: FLEXION OR DORSIFLEXION.

consequently dorsiflexion of the foot is associated with slight eversion and abduction, and extension or plantar flexion with slight inversion and adduction. Owing to the shape of the upper surface of the astragalus, lateral movement at the ankle-joint is only possible, and to a limited degree, during full plantar flexion.

(d) **The Tarsal Joints** (Fig. 27).

The most important movements occurring at the tarsal joints are inversion and eversion, adduction and abduction,

and combinations of those movements known as supination and pronation (Figs. 31 and 32).

Inversion.—In this movement, the whole foot rotates about an antero-posterior axis, so that the sole of the foot is directed inwards and downwards.

Eversion is the opposite and less extensive movement, in which the sole is directed outwards and downwards.

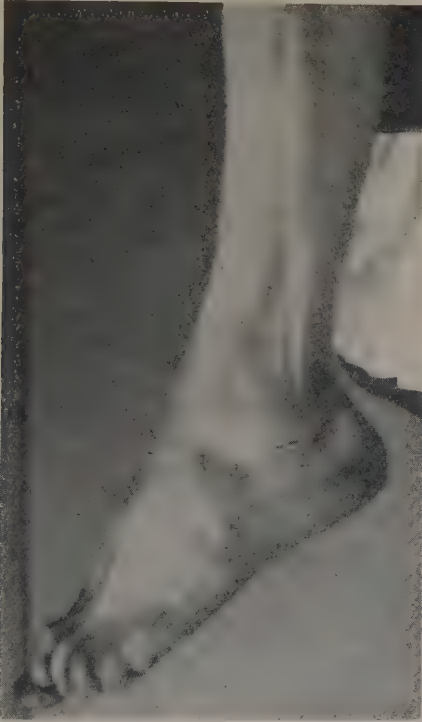


FIG. 30.—MOVEMENTS OF ANKLE: EXTENSION OR PLANTAR FLEXION.

These movements occur, not only at the mid-tarsal joint, between the astragalus and os calcis behind and the scaphoid and cuboid in front, but also at the joint between the astragalus and os calcis (subastragaloid).

Abduction is the movement outwards of the front part of the foot at the mid-tarsal joint.

Adduction is the movement inwards of the front part of the foot at the same joint.

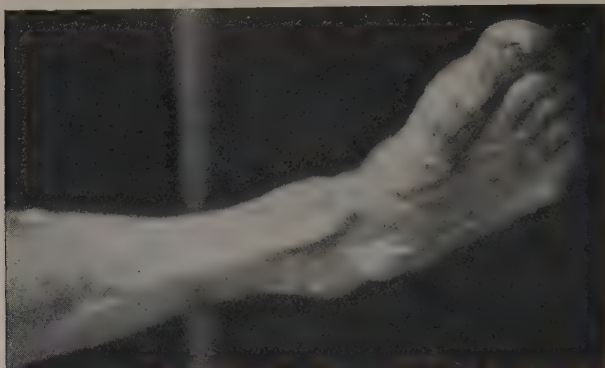


FIG. 31.—MOVEMENTS OF FOOT: INVERSION COMBINED WITH ADDUCTION.

Pronation is a combination of eversion and abduction.

Supination is a combination of inversion and adduction.

The last two movements of the foot are also applied to posi-

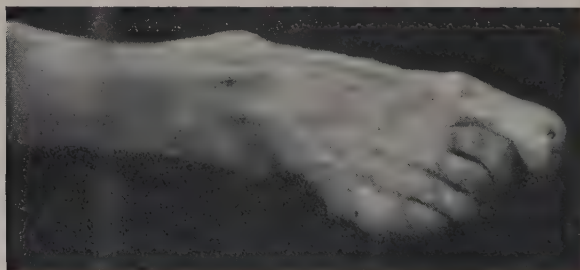


FIG. 32.—MOVEMENTS OF FOOT: EVERSION COMBINED WITH ABDUCTION.

tions, especially in the weight-bearing foot. In standing, for example, the weight-bearing foot tends to assume the pronated position.

Manipulation of the Ankle and Joints of the Foot.

In the consideration of limitation of movement at the ankle-joint, having excluded limitation due to bone, it is necessary to distinguish between two different causes. Firstly, limitation primarily due to an affection of the joint, which has brought about the presence of synovial adhesions, or actual scarring of the capsule. Secondly, limitation of movement due to secondary shortening of tendons and other peri-articular structures, or that which is primarily, and often solely, due to peri-articular adhesions in or about tendon sheaths.

As an example of stiffness due to primary affections of the joint, we may cite adhesions following traumatic synovitis due to sprains or contusions, infective synovitis, and chronic arthritis. Fractures into the joint or fracture-dislocations, such as Pott's fracture, in which prolonged immobility has been practised, are also potent causes of stiffness of the ankle-joint. It should be noted that in some of these cases, the limitation of movement is due in part to definite bony obstruction, and in these open operation combined with manipulation is a valuable measure. In other cases, as we have seen, the stiffness is due more to causes around the joint. A good example of this condition is seen in talipes equinus or equinovarus, where, through faulty treatment, a shortening of the tendo Achillis has taken place which causes limitation of dorsiflexion at the ankle-joint. In the opposite and rarer condition of talipes calcaneus, there may be limitation of plantar flexion at the ankle-joint.

It should be remembered also, as in the case of the wrist, that many sprains in the region of the ankle are tendinous in nature, and that these may lead to limitation of movement of the ankle-joint or other joints in its immediate neighbourhood. This may be so slight that it is revealed only by the most careful examination, yet this limitation may be sufficient to give rise to very considerable disability. It is not difficult to grasp this fact, if we remember the number and importance of the tendons that lie in the immediate vicinity of the joint. Adhesions often occur after a sprain of the extensor tendons

on the anterior aspect of the ankle, between one or more of the tendons and its synovial sheath, or between the tendons and one or other portion of the anterior annular ligament. Similarly, such adhesions may occur on the outer or inner side of the ankle, and manifest themselves by localised pain and tenderness, and by pain accompanying such movements as stretch the affected tendon or tendons. This will be clear if the surgical anatomy of this most important and somewhat complicated region be revised.



FIG. 33.—MANIPULATION OF ANKLE: DORSIFLEXION.

Manipulative Technique.—The patient should preferably lie upon a couch, and an anæsthetic is advisable except in minor cases. The surgeon grasps the front part of the foot firmly with one hand, and with the other grasps the lower part of the leg above the malleoli (Fig. 33). In performing dorsiflexion, it is an advantage in most cases first to flex the knee in order to relax the gastrocnemius and soleus. Plantar flexion should be performed with the knee extended. Traction must be exercised during these movements. When adhesions exist

in the extensor sheaths, firm thumb pressure should be exerted upon any particularly tender spot, and a rapid movement of plantar flexion performed. In the case of adhesions involving the flexor tendons behind the internal malleolus similar pressure is adopted, but the foot is forcibly dorsiflexed and everted, and in the case of adhesions involving the peronei tendons, the foot is dorsiflexed and simultaneously inverted. When dorsiflexion is limited by contracture of the tendo Achillis, much can often be done by one or more manipulations, if the case prove not amenable to passive movements and gymnastic exercises. In obstinate or marked cases, manipulation must be combined with open or subcutaneous tenotomy of the tendon. The latter step should be avoided if possible.

Manipulation of the Tarsal Joints.—The most important of the tarsal joints is the mid-tarsal, which is constituted on the outer side by the articulation of the os calcis behind with the cuboid anteriorly, and on the inner by the head of the astragalus behind with the scaphoid anteriorly. At this most important joint, and particularly in its inner segment, the movements of inversion and eversion and of abduction and adduction take place.

A detailed discussion of the important problem of the causation and treatment of flat-foot is beyond the scope of this short work. Suffice it to say, that in many cases, the longitudinal arch, of which the head of the astragalus forms the key-stone, drops, and the foot becomes everted and pronated at the mid-tarsal joint. At first the patient is able to restore the arch, voluntarily correct the deformity, and invert the affected foot by muscular effort. In the later, and, alas ! neglected stages this is impossible, because the deformity has become fixed by scar tissue and by secondary shortening of peri-articular tendons and other structures, and in the most marked cases by changes in the shape of the bones. When contracture has occurred of slight or moderate degree, manipulation is often a most valuable measure combined with appropriate after-treatment. The latter is, indeed, of great importance, for without it we are merely converting a case of

flat-foot of the second or third degree into one of the first degree, and the whole process is apt to be repeated.

The patient lies upon a couch with the knee flexed, and the surgeon, grasping the heel with one hand and the front part of the foot with the other, forcibly inverts the foot, using, in obstinate cases, as a fulcrum a wedge-shaped block covered with leather upon which the middle of the inner border of the foot rests (Fig. 34). The use of Thomas's wrench in



FIG. 34.—MANIPULATION OF MID-TARSAL JOINT: INVERSION AND ADDUCTION.

difficult cases of stiffness of the mid-tarsal and ankle joints constitutes a valuable aid owing to the powerful leverage obtainable. Needless to say, this instrument must be used with great care, and the force employed must be steady and continuous and never spasmodic. In more marked cases, a series of manipulations is advisable, and this is certainly to be preferred to the practice of using considerable force followed by fixation of the foot in the corrected position in plaster followed by some surgeons.

In deformities of the feet occurring in infants and young persons temporary fixation in plaster after manipulative correction may be a wise step, owing to the great difficulty of proper control and after-treatment.

Having restored the mobility of the mid-tarsal joint, our guiding principle in after-treatment must be to develop by appropriate exercises the muscles which control the arch of the foot, weakness of which is an important factor in the ætiology of the condition. The principle of weight deflection to the outer side of the foot is to be simultaneously observed, and this can in most cases be achieved by the simple device of raising the inner side of the sole and heel of the shoe on the affected side or sides, combined, if necessary, with stiffening of the uppers on the inner side, which is more satisfactory than an internal arch support. It is now probably sufficiently clear why immobilisation in plaster after correction so often fails, for the inevitable muscular wasting that follows militates against that building-up of muscular power which is one of the most essential parts of the treatment of this common and painful condition.

But in addition to the cases in which flat-foot is obviously present, there are many cases of painful feet, some of which have followed an injury, while in others no such injury can be elicited, in which the evidence points to some slight loss of the normal gliding movement between individual tarsal bones, and in which manipulation is often of very marked benefit. In some cases of metatarsalgia, also, manipulation does great good, owing, probably, to the presence of adhesions. The heads of adjacent metatarsal bones should be firmly grasped in turn by the forefinger and thumb of the surgeon, and moved upwards and downwards in opposite directions. The transverse arch is then restored, and retained in the corrected position by a band of adhesive strapping for twenty-four hours. Thereafter, exercises to develop the intrinsic muscles of the sole are instituted, and the patient ordered special shoes which provide a support beneath the necks of the metatarsal bones. Here, again, it is possible to restore the freedom of the transverse arch and retain it temporarily in the corrected

position, but the success of the manipulation depends to a considerable degree upon carefully planned and religiously performed after-treatment.

Manipulation of the Great Toe.—A condition of osteo-arthritis of the metatarso-phalangeal joint of the great toe is very frequently encountered. It is almost certainly in most cases a form of traumatic osteo-arthritis, due to the wearing of ill-fitting boots and shoes. There is a type of long, narrow foot which is not catered for by the "ready-made" boot or shoe, and which is particularly prone to develop a form of traumatic osteo-arthritis of this joint, because the toes are continually being crowded into the front part of the shoe and subjected to constant minor traumata. It is apt to give rise to a painful limitation of dorsiflexion of the great toe of the affected foot. In the later stages the limitation of movement is due to osteophytic formations, but in the early stages this is not the case, and an attempt to restore the power of dorsiflexion should always be made by manipulation. If thereafter proper boots and shoes are ordered, and the joint put through its full range of movement daily, limitation by osteophytes can be prevented. In fact, as the author sometimes tells students, "one can train up an osteophyte in the way it should grow."

Manipulation of Ankle-Joint—Illustrative Cases.—

CASE I.—Captain M. fractured lower third of right fibula one year previously. This was treated for some time as a sprained ankle. After the accident, he experienced pain in the ankle, with slight swelling and a tired feeling after games. More recently, his ankle frequently "turned over" at golf.

On Examination.—Localised tenderness over anterior part of external lateral ligament, with pain on full inversion. Slight irregularity of the external malleolus.

Manipulation.—Forcible inversion associated with thumb pressure over tender area. Immediate massage and exercises instituted. Satisfactory result.

CASE II.—K. M. sustained Pott's fracture of the left ankle three months previously; long period of rest was ordered.

Now complaining of pain in the front of the ankle and swelling after exercise. Has had a long course of massage and movements.

On Examination.—Ankle movements, both active and passive, restricted 25 per cent.

Manipulation was performed and full movements obtained, during which adhesions audibly gave way. Satisfactory result.

CASE III.—C., aged 42, was knocked down by a waggon nearly a year previously, which passed over both lower extremities, and he sustained, amongst other injuries, a lesion of the right sciatic nerve. No attempt had been made to prevent deformity, and the right foot was firmly fixed in the equinovarus position, and marked contracture of the tendo Achillis was present. A very slight degree of movement was present in the flexors and extensors of the ankle and toes, and marked wasting of the leg muscles was present with sensory changes.

Operation.—A subcutaneous tenotomy of the tendo Achillis was performed in two places, and by means of a Thomas's wrench the deformity was overcome with considerable difficulty, owing to the stiffness of the ankle and mid-tarsal joints. The corrected position was maintained at first by a splint, although massage and electrical treatment were continued. In a few weeks he was able to walk in a special boot furnished with a toe-raising spring, and owing to the correction of the deformity, the best conditions were present for gradual recovery of function. The man has since resumed his previous occupation as a waggoner.

It should be noted that, whenever possible, it is more advantageous to stretch the tendo Achillis by passive movements or manipulation than to perform tenotomy or tendon lengthening.

Manipulation of Mid-Tarsal Joint—Illustrative Case.—

Mrs. T. had an attack of "fever" in India, associated with "pains all over," which disappeared except in the right foot, which became swollen and stiff. A certain amount of improvement followed a course of vaccines, a culture being obtained from the root of an infected tooth.

On Examination.—Considerable limitation of inversion of the right foot, with tenderness over inner aspect of the mid-tarsal joint.

Manipulation was performed, the foot being firmly inverted at the mid-tarsal joint over a wedge, and an appreciable increase of movement obtained. No retentive apparatus was

applied, but evaporating lotion was used for twenty-four hours and immediate massage instituted. At the end of this period, active and passive movements were permitted, and shoes raised upon the inner side of the soles and heels ordered. By perseverance, the patient consolidated the ground gained by the manipulation, and was able to walk without pain.

**Manipulation of Metatarso-Phalangeal Joint of Great Toe—
Illustrative Case.—**

Mrs. B. ten years ago had severe attack of pain and inflammation in metatarso-phalangeal joints of the great toes. This remained quiescent for some years, but latterly has been very troublesome.

On Examination.—Marked limitation of dorsiflexion of both great toes at metatarso-phalangeal joints, with a certain amount of bony thickening. The latter, however, was not the actual cause of the limitation of movement.

Manipulation was performed, a marked increase of range obtained, and immediate active and passive movement instituted, preceded by radiant heat. The improvement was maintained, and the patient was able to take up classical dancing.

She wrote two years later: "Since the manipulation my feet have never pained me, and I walk like a normal individual."

CHAPTER VI

THE UPPER EXTREMITY

(a) The Shoulder-Joint.

Surgical Anatomy (Fig. 35).—In this ball-and-socket joint the head of the humerus articulates with the shallow glenoid cavity of the scapula, which is deepened slightly by the glenoid ligament, formed of dense fibro-cartilaginous tissue. The articular capsule is extremely lax, and is attached proximally to the margin of the glenoid cavity and its ligament, and distally to the anatomical neck of the humerus above, but below it is attached to the surgical neck, half an inch from the head. With the arm hanging by the side, a well-marked pocketing of the capsule occurs below and on the inner side, which becomes obliterated during abduction. Two, and sometimes three, gaps are present in the capsule, through which bursal protrusions of the synovial membrane occur. The first permits the long tendon of the biceps, surrounded by a bursal sheath, to emerge from its origin within the joint to commence its extracapsular course. The second, on the anterior aspect, allows the synovial cavity to communicate with the bursa beneath the subscapularis. The third, when present, communicates with the bursa beneath the infraspinatus. The capsule is strengthened by the tendons of the supraspinatus, infraspinatus, and subscapularis, which are partly inserted into it, and is weakest below, at which site dislocation usually occurs.

Accessory Ligaments. — The coraco-humeral ligament strengthens the upper part of the capsule, and stretches from the outer border of the coracoid process to the anatomical neck in the region of the great tuberosity. The gleno-humeral bands are three in number—superior, middle, and inferior.

They are ill-marked bands, which stretch between the anterior border of the glenoid cavity and the anatomical neck of the humerus, and lie between the capsule and the synovial membrane. They are best demonstrated by removing the posterior part of the capsule and the head of the humerus, and looking into the joint from behind. The superior (gleno-humeral

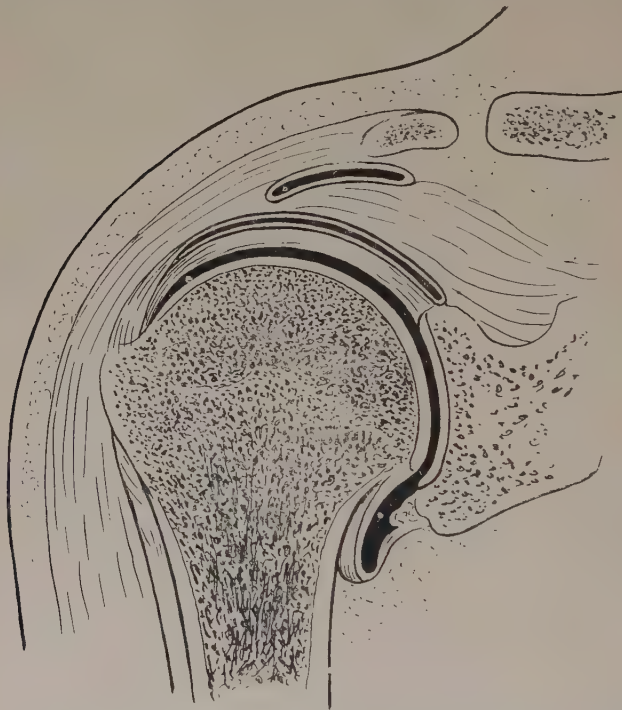


FIG. 35.—SECTION THROUGH SHOULDER-JOINT, SHOWING ARRANGEMENT OF SYNOVIAL MEMBRANE.

ligament), according to Bland-Sutton, represents the divorced tendon of the subclavius muscle. It is fixed above to the apex of the glenoid cavity, close to the root of the coracoid process, and passes downwards to the inner side of the biceps tendon to be attached to a small depression above the lesser tuberosity of the humerus. The middle band reaches from the anterior margin of the glenoid cavity along the lower

border of the subscapularis tendon to the lower border of the lesser tuberosity. The lowest runs from the lower part of the glenoid to the under part of the anatomical neck of the humerus.

Synovial Membrane.—This covers the glenoid ligament, and is then reflected on to the capsule, the deep surface of which it clothes. When the arm hangs by the side, a well-marked pouch of synovial membrane exists below (Fig. 35). The opposed layers of this pouch are very liable in certain inflammatory conditions to become adherent, owing to organisation of plastic lymph, and painful limitation of abduction ensues. The membrane is reflected from the capsule on to the anatomical neck of the humerus above and on either side, and on to the surgical neck below and internally, whence it runs to the edge of the articular cartilage. The long tendon of the biceps, which passes through the joint, is surrounded by a tube of synovial membrane, and is therefore extrasynovial, but intracapsular. The bursal protrusions from the general synovial cavity have already been noted.

In testing the movements of the shoulder-joint itself, it is most important not to confuse the true shoulder movements with the scapular movements that take place at the sternoclavicular and acromio-clavicular joints. For this purpose, the scapula should be fixed. Before discussing the shoulder movements proper, a short description will be given of these scapular movements.

Scapular Movements.—It is important to remember that the scapula follows the clavicle in its movements, but that a certain amount of gliding takes place at the acromio-clavicular joint, which permits the scapula to remain in contact with the chest wall, and preserves the normal relationships of the glenoid cavity and the head of the humerus. The following scapular movements occur:

Elevation of the shoulder, during which the clavicle moves on its articular disc. This movement is checked by the costoclavicular ligament.

Depression of the shoulder, which is checked by the interarticular disc and the interclavicular ligament.

Movement forwards and backwards of the shoulder, during which the clavicle and disc move on the sternum.

Circumduction is a combination of these movements.

Shoulder Movements (Fig. 36).—As the scapula takes part in most of the movements, the determination of the actual movements at the shoulder-joint itself must be difficult, variable, and liable to inaccuracy.

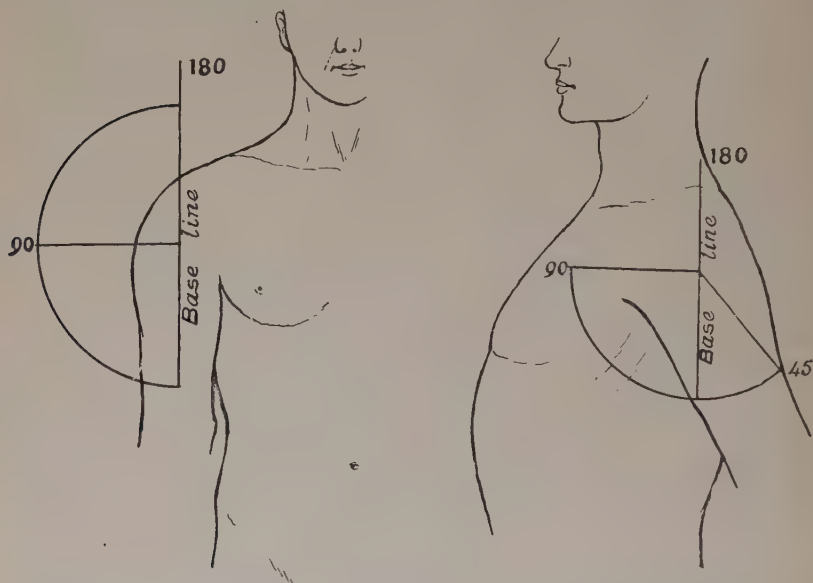


FIG. 36.—DIAGRAMMATIC REPRESENTATION OF RANGE OF SHOULDER MOVEMENT.

Flexion (Fig. 37), or movement forwards and upwards in the antero-posterior plane, takes place as far as the horizontal principally at the shoulder-joint, but in carrying the arm upwards beyond this point to the vertical position, the scapula, in addition, moves upwards upon the chest wall. The complete range of flexion is, therefore, through an arc of 180 degrees.

Extension (Fig. 38), or movement backwards in the antero-posterior plane, takes place to a similar extent, but is also possible behind the long axis of the body through about 45

degrees combined with scapular movement. This latter movement is sometimes termed hyperextension.

Abduction (Figs. 39 and 40), or movement outwards of the arm in the frontal plane of the body, is possible through 90 degrees, this movement being very largely at the shoulder-joint. Having reached this point, the lower part of the capsule becomes taut, the great tuberosity of the humerus impinges against the acromion process and coraco-acromial ligament, and further movement,* now known as **elevation**



FIG. 37.—MOVEMENTS OF SHOULDER: FLEXION.

(Fig. 41), is produced by rotation of the scapula upon the chest wall by the trapezius and serratus magnus muscles. This movement takes place at the sterno-clavicular and acromio-clavicular joints, and is possible until the arm assumes the vertical position. The complete range covered by the combined movements corresponds to an arc of 180 degrees.

Adduction, or depression of the arm in the frontal plane to the side, occurs through a similar range, and is then stopped

by contact with the trunk. If, however, the arm be then flexed, a further degree of movement inwards is possible through about 50 degrees (horizontal adduction). Movement outwards in this plane (horizontal abduction) is possible through 90 degrees.



FIG. 38.—MOVEMENTS OF SHOULDER: EXTENSION.

Rotation (Figs. 42 and 43).—The total amount of rotation possible rarely exceeds 90 degrees when the arm is either at the side or fully abducted. With the arm only partially abducted, rotation through about 135 degrees is possible.



FIG. 39.—MOVEMENTS OF SHOULDER: ABDUCTION (ANTERIOR VIEW).

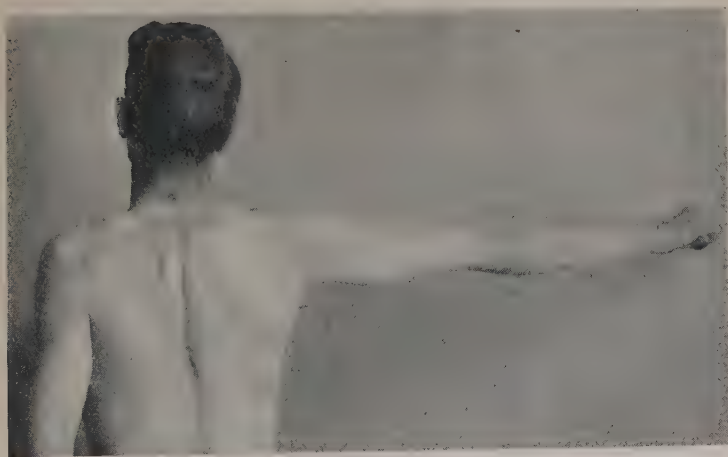


FIG. 40.—MOVEMENTS OF SHOULDER: ABDUCTION (POSTERIOR VIEW).
The inferior angle of the scapula retains its normal position.

Circumduction is a combination of the above movements in which the arm describes a cone, the apex of which is situated at the shoulder-joint.

Manipulation of the Shoulder-Joint.

It is of the greatest importance to distinguish carefully between the limitation of movement which occurs at the



FIG. 41.—ELEVATION OF ARM.

The inferior angle of the scapula has travelled outwards and upwards.

shoulder-joint and that which is due to limitation of scapular movement. A slight degree of limitation of movement at the



FIG. 42.—MOVEMENTS OF SHOULDER: ROTATION INWARDS DURING ABDUCTION OF ARM.



FIG. 43.—MOVEMENTS OF SHOULDER: ROTATION OUTWARDS DURING ABDUCTION OF ARM.

shoulder-joint sufficient to give rise to much pain and disability may be entirely masked by compensatory scapular movement. In some cases, there is limitation of shoulder and scapular movement combined, and in others the limitation of movement is due to involvement of the subacromial or subdeltoid bursa. It is surprising, however, to find how rarely the scapula is fixed by adhesions. Limitation of movement at the shoulder-joint by adhesions is apt to follow sprains, contusions, and dislocations of the joint; fractures of the neck or great tuberosity of the humerus, fractures of the acromion process of the clavicle or scapula, or of the glenoid process of the scapula; synovitis of a toxic or infective nature; and acute or chronic arthritis. More rarely the limitation of movement may be due to causes outside the joint, such as scarring of the surrounding muscles following wounds, prolonged suppuration, or burns.

Prevention of Deformity.—The position which the arm tends to assume in the more severe inflammatory affections of the shoulder-joint is one of adduction, slight flexion, and internal rotation. Experience teaches, however, that perhaps the best position, should ankylosis unfortunately occur, is that in which the arm is abducted through 60 degrees at the shoulder-joint in adults (rather more in children), and slightly flexed. Care should be taken that the elbow lies a little anterior to the mid-axillary line, and that the scapula retains its normal position of rest. If, then, a patient is seen with an acute condition of the shoulder-joint in which the adducted position has been assumed owing to uncontrolled muscular spasm, the arm, as a preliminary measure, should be very carefully and gently, and under anæsthesia if necessary, placed in the correct position, and retained thus until such time as the principle of early movement, wherever feasible, can be instituted.

As in these early stages the limitation of movement is largely due to muscle spasm, there is no great difficulty and very little danger about such a procedure if care be exercised. If our efforts to retain a movable joint fail owing to the acuteness of the inflammatory process, the arm is nevertheless in

the best possible position for ankylosis. Moreover, by scapular movement a considerable degree of elevation is possible, so that such actions as shaving and brushing the hair are easily performed. If our efforts to secure a movable joint are to be crowned with success, the position of election above-mentioned forms an excellent starting-point for movements, and should be maintained at first in the intervals of such movements combined with re-education.

Manipulative Technique.—In all cases in which we are confronted with stiffness of the shoulder in which there is no tendency for such movement as exists to diminish as the result of very careful movement, it is necessary to formulate a plan of campaign. It may be stated at once that cases of true ankylosis in bad position are more suitable for open operation, such as osteotomy of the humerus to correct adduction, or in some cases arthroplasty. Such operations, however, are not indicated where the ankylosis is fibrous or due to shortening of the capsule, peri-articular tendons, and other structures.

When limitation of movement is slight, a single manipulation may be sufficient to effect a cure. When, however, limitation of movement is marked, it is futile and dangerous to attempt to overcome this by a single manipulation, but movement should be gradually restored by a series of manipulations separated by intervals, during which after-treatment is assiduously and religiously followed. Some of the most obstinate types of stiffness will often improve to a quite extraordinary extent by a carefully planned series of manipulations associated with the necessary after-treatment, which is of paramount importance. In cases of minor degrees of limitation of movement (Fig. 44) the scapula is fixed by the surgeon, the arm grasped just above the elbow, and put through its full range of movements at the shoulder by a series of firm, rapid, and purposive movements.

It is advisable first to loosen the joint somewhat by rotation, and to bear in mind that the amount of rotation normally possible varies with the position of the limb.

For instance, after first rotating, the limb is then adducted

to the mid-line and again rotated. Still fixing the scapula, flexion and extension are next performed, each movement being followed up by rotation.

Next abduction is performed carefully, preferably with an assistant pressing upwards with the fist in the axilla, for during this movement dislocation is apt to occur. The fixation of the scapula may be assisted by pressure against its inferior angle. When abduction is complete, rotation is again carried out. The scapula may now be released and

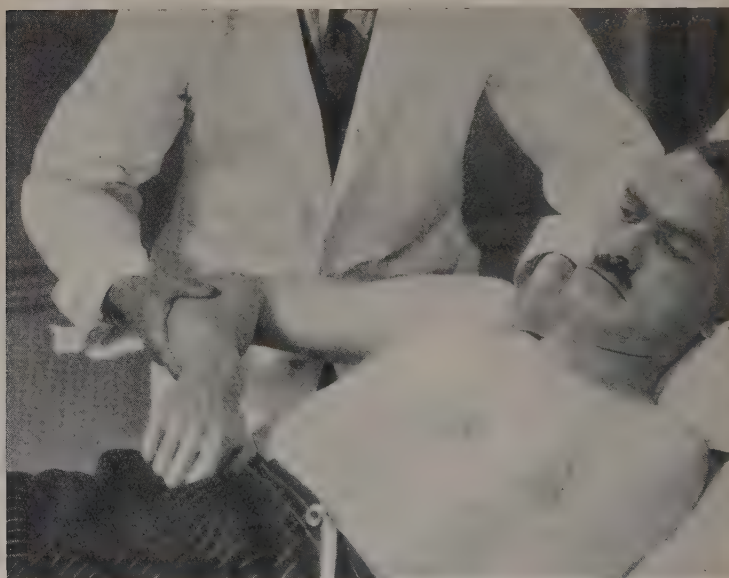


FIG. 44.—MANIPULATION OF SHOULDER. METHOD I: LONG LEVERAGE

elevation, both forwards and outwards, executed. Circumduction through gradually increasing circles is next performed. This is a movement which on no account should be omitted.

Re-education should commence immediately, and the arm should be kept in the position which was previously impossible until the patient has recovered from the anæsthetic, the patient being instructed to perform almost immediately the movement previously restricted and painful. The psycho-

logical effect of this is most important, and should never be neglected.

In cases of more obstinate stiffness (Figs. 45 and 46) the scapula is fixed as above, but owing to the risk of fracture of the neck of the humerus or of dislocation, if a long leverage be employed, the other hand of the surgeon grasps the upper arm just below the axillary level, and the prevention of dislocation by an assistant pressing the fist upwards into the axilla is even more strongly indicated. It is a wise measure to be content with a little increased range of movement in all directions, rather than to risk fracture by attempting too much at first, and it should be remembered that a too forcible movement of rotation is the one most likely to cause fracture.

In such obstinate cases, the arm should be retained as fully abducted as possible by an abduction splint, in the intervals of massage and movements.

At the risk of repetition, emphasis must be again laid upon the importance of carrying out all these movements with extreme care, and of avoiding fracture of the surgical neck of the humerus during rotation by the methods already described. It is most important to remember that in some cases adhesions are present in the sheath of the biceps tendon. These are best dealt with by extending the arm at the shoulder-joint while the patient is lying upon the opposite side, or with the affected shoulder projecting beyond the edge of the couch. The elbow should also be extended, and firm kneading of the tendon as it lies in the bicipital groove carried out in addition.

Manipulation of Shoulder—Illustrative Cases.—One of the most frequent causes of stiffness of the shoulder is too prolonged immobility after the reduction of a dislocation of the shoulder-joint. If the stiffness and limitation of movement be slight, a single manipulation will often suffice. In more marked cases, it is wise to arrange a series of manipulations.

CASE I.—M., aged 20, six months before fell from bicycle on to left shoulder, and sustained dislocation thereof. This was reduced the next day; massage was instituted immediately, and movements after ten days. Movements gradually increased, and after a while he was able to resume playing



FIG. 45.—MANIPULATION OF SHOULDER. METHOD 2: SHORT LEVERAGE



FIG. 46.—MANIPULATION OF SHOULDER. METHOD 2: SHORT LEVERAGE.
During abduction of the arm, the assistant presses firmly upwards into the axilla to prevent dislocation of the head of the humerus.

games, but very slight limitation of elevation, extension, and circumduction remained, which interfered with his bowling. More recently the pain in the left shoulder had increased.

On Examination.—Full elevation of arm both forwards and outwards slightly restricted and painful. Extension, rotation, and circumduction similarly restricted.

Definite tenderness present over front of shoulder-joint in line of biceps tendon.

Manipulation performed in the usual way for slight degrees of stiffness, and firm kneading applied to local tender area. Exercises and re-education commenced the same day. Patient made an immediate recovery.

CASE II.—Mrs. M., aged 50, complained of pain in the left shoulder and down inner side of arm extending to hand, together with limitation of movement of the shoulder-joint. She had an attack of rheumatic fever at the age of eleven years, since which she had been subject to attacks of "rheumatism," particularly in the arms and legs. The pain in the left shoulder and arm had been much more marked during the past twelve months. She had been treated at a spa with applications of peat to the shoulder, which had been immobilised for a long period. She had also had more recently a long course of electrical treatment, massage, and movements, which caused considerable relief. The inability to raise the arm above shoulder level was, however, a grave inconvenience.

On Examination.—Abduction of the arm was possible to an angle of 90 degrees with scapular movement, the actual movement at the shoulder-joint itself being slight. All other true shoulder movements were limited by 50 per cent. There was well-marked wasting of the muscles of the shoulder-girdle and upper arm. Crepitus was present on movement, and X ray showed evidence of chronic arthritis of the shoulder-joint, but no obvious osteophytes were present.

As previous massage and exercises had actually caused a diminution of pain, it was decided to manipulate the shoulder, and to follow this treatment by exercises to perpetuate the increase of movement obtained. Manipulation was accordingly performed under general anæsthesia. The scapula was fixed, and the arm first carefully abducted. During this movement adhesions were definitely felt to give way. Full abduction was thus obtained, and on releasing the grip on the scapula, full elevation. The remaining movements of the shoulder were then carefully obtained by further manipulation. The patient remained in bed for twenty-four hours, during which the limb was retained in almost full elevation by means of a Thomas's extension arm splint with movable

ring. Massage was instituted almost immediately, and movements at the end of twenty-four hours.

The patient derived great benefit, for pain was appreciably lessened, and the restoration of movement, particularly of elevation, was preserved by appropriate exercises, and enabled the patient to carry out acts previously impossible.

CASE III.—Mrs. S. dislocated left shoulder some months before. Apparently the dislocation was overlooked. She declined open operation, and owing to the time that had elapsed, manipulative replacement was not considered advisable. The anatomical neck of the humerus lay against the glenoid margin. There was a complaint of "neuritis" in the arm, and considerable stiffness and limitation of movement at the shoulder-joint.

Manipulation was performed with extreme care. As was expected, it was found impossible to reduce the dislocation, but the movements were increased nearly 50 per cent., and the patient found thereafter that she had quite a useful arm and was able to do her hair.

CASE IV.—A medical man complained of marked stiffness of the right shoulder, and very severe pain, not only in the joint, but in the whole limb, principally in the musculo-spiral nerve distribution. Wasting of the muscles of the shoulder-girdle and arm existed, and movement forwards and outwards of the arm was possible with scapular movement to a right angle only. He had previously been treated by manipulation elsewhere, but the joint re-stiffened, probably because an attempt was made to regain full movement at one session. He was depressed and almost worn out with pain and sleepless nights.

The history of the patient's condition is given in the following abstract supplied by the patient:

History of Accident.—On November 1st, going down ice-coated steps, heels went from under me. Both arms were flung involuntarily upwards, outwards, and backwards. Very distinct sensation of a 'snap' in region of right shoulder joint, with excruciating pain which lasted some minutes. Diagnosis—tear of muscle. Pain continued—movements caused increased pain.

Treatment.—Rest, support of arm, hot baths and later massage.

December 15th.—Condition slowly improving, boring pain in region of joint, occasional intervals of freedom from pain; movements, unless quite gentle, caused increased pain. Inadvertent abduction and rotation particularly, caused very

severe pain at deltoid ridge of humerus, as well as about the head of humerus.

January.—X ray showed no fracture.

Treatment.—Radiant heat, artificial sunlight, massage, and passive movements for three weeks. Pain worse—deep boring ache in joint. Diagnosis—‘tear of capsule.’

February.—Advised more complete rest, with sling and bandage.

April.—Pain rather worse—especially at night—painful areas about scapula and down arm to the hand, chiefly radial side.

Painful stiffness of the whole arm, especially in mornings. Movements limited; adhesions formed.

April 30th.—Nursing Home, general anæsthetic. Adhesions broken down, arm put through considerable movements, and fixed in full elevation.

Result.—Pain on moderate abduction no longer occurs, but otherwise pain just as bad as before. Treatment since then—radiant heat, massage, and passive movements.

Result.—Movements improving, but pain, if anything, has been more severe; at times much more so down the arm to hand. Fingers have been a little swollen this week, and I think the arm also a little. Rarely sleep through the night, owing to severity of boring pain.”

It was decided to attempt to restore full movement to the shoulder by a series of manipulations. At the first manipulation, which was performed under gas and oxygen anæsthesia, a 50 per cent. increase of movement was obtained. The arm was temporarily retained abducted through 45 degrees by sandbags. Radiant heat, massage, and movements were instituted the same day and continued daily. A fortnight later, a second manipulation under gas and oxygen was performed, and movement still further increased. A month later, the increased range was still maintained, pain was considerably less, and muscular power was improved. Internal rotation was, however, still somewhat restricted. A third and final manipulation was therefore carefully performed under chloroform and ether anæsthesia, resulting in almost complete return of rotation. After a few more weeks of radiant heat, massage, and exercises, the movement of the shoulder was found to be perfect, pain was negligible, and the patient's general condition was so far improved that he was able to resume his professional duties.

(b) The Elbow-Joint.

Surgical Anatomy (Fig. 47).—The elbow is a hinge-joint in which the greater sigmoid cavity of the ulna articulates with

the trochlear surface, and the radial head with the capitellum of the humerus. It depends for its strength more upon the shape of its articular surfaces than upon surrounding ligaments. In connection with this articulation, we must also consider the superior radio-ulnar joint, the synovial membrane of which is directly continuous with the elbow-joint. At the superior radio-ulnar joint, the head of the radius articulates with the lesser sigmoid cavity of the ulna.

Ligaments.—The articular capsule is strengthened at certain spots. The *anterior ligament*, which is somewhat weak, is

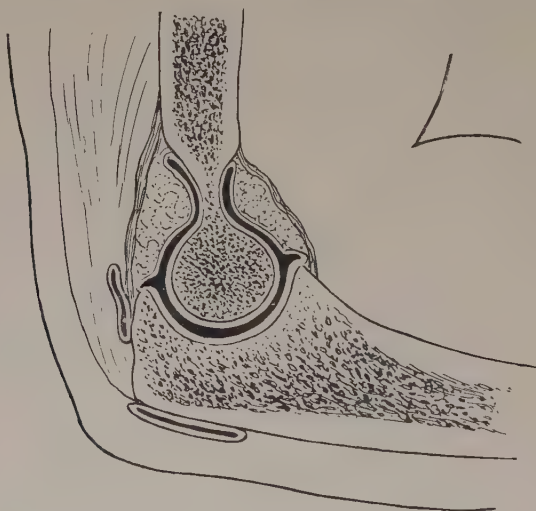


FIG. 47.—SAGITTAL SECTION OF ELBOW-JOINT.

attached proximally to the margins of the coronoid and radial fossæ, and to the internal condyle, and below to the margins of the coronoid process and to the orbicular ligament.

The *posterior ligament*, also weak, is attached above to the margins of the olecranon fossa and to the external condyle, and below to the anterior and lateral margins of the olecranon process.

Internal Lateral Ligament.—Is triangular in shape. The apex, which is above, is attached to the internal epicondyle of the humerus. The base is attached to the inner margins of the

coronoid and olecranon processes, and to a transverse ligament connecting these two attachments.

External Lateral Ligament.—Stretches between the lower part of the external epicondyle and the annular ligament.

Synovial Membrane.—Lines the deep surface of the capsule, the floors of the olecranon, radial and coronoid fossæ, and covers the deep surfaces of the pads of fat lying in these fossæ, which intervene between the capsule and the synovial membrane (see Fig. 47). It sends a protrusion downwards to line the capsule of the superior radio-ulnar joint.

Movements (Fig. 48).—At the elbow-joint proper movements of flexion and extension occur. Owing to the obliquity of the trochlear surface of the humerus, the forearm on flexion inclines inwards and brings the hand towards the mid-line. On extension, the forearm inclines outwards, and on full extension makes an obtuse angle with the upper arm, which constitutes the “carrying angle.” Extension is possible to a straight line, although in some persons a few degrees of hyperextension are normally allowed. Flexion takes place until the forearm forms an angle of 45 degrees with the base line.

SUPERIOR RADIO-ULNAR JOINT.—Pivot joint. The annular or orbicular ligament, which forms three-quarters of a circle, surrounds the head of the radius, and is attached to the anterior and posterior margins of the lesser sigmoid cavity of the ulna. It narrows where it encircles the neck of the radius, to which it is very loosely attached, so that the bone is enabled to rotate upon its own axis. Fibres of the anterior, posterior, and external lateral ligaments of the elbow are attached to its corresponding surfaces, and some fibres of the supinator brevis arise from its outer surface. A thickened band which passes from just below the lesser sigmoid cavity of the ulna to the neck of the radius is known as the quadrate ligament.

The *Synovial Membrane* of the joint is continuous with that of the elbow-joint.

Movements.—A purely rotatory movement of the radial head, which brings about pronation and supination of the forearm.

Manipulation of the Elbow-Joint.

Prevention of Deformity.—In addition to the causes of stiff joint already enumerated, the interesting condition, myositis ossificans, must always be borne in mind when faced with a stiff elbow-joint, particularly in a young person. The inflamed elbow-joint tends to become fixed in a position midway between flexion and extension with the forearm pronated. The best position for ankylosis is probably when the arm and forearm form an angle of 90 degrees at the joint, as this position permits

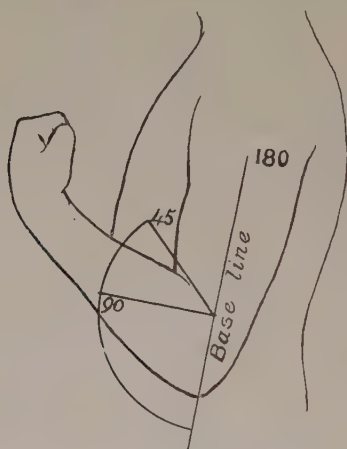


FIG. 48.—MOVEMENTS OF ELBOW.

the hand to be brought to the mouth or the head. The occupation and wishes of the patient should, however, always be consulted in this matter, as some persons would doubtless prefer the elbow-joint to be fixed at a greater angle. If both elbows are affected, it is advisable that one should be fixed at rather less and the other at rather more than a right angle.

When, therefore, we are faced with a somewhat acute condition of the elbow-joint in which fixation by muscle spasm in the partly extended position has occurred, the forearm must be brought into a better position by gentle manipulation, and retained thus temporarily.

There is a tendency for an intractable type of stiffness to occur in the elbow-joint after fracture or contusion unless great care in after-treatment is taken. This is particularly apt to occur in young persons.

The mistake often made is to manipulate the joint forcibly and with an absence of proper method, and it is scarcely surprising when, as so often happens, the elbow promptly re-stiffens.

The golden rule in these cases is to ensure full flexion at first, when the extension can usually be relied upon to return gradually, provided the movement is not unduly forced. If this rule has been neglected, the joint may be carefully manipulated in order primarily to restore full flexion, the forearm bandaged in this position, and extension gradually restored by active movements preceded by gentle massage.

Each day, as we gradually win a few more degrees of active extension, care must be taken that the patient voluntarily bends the elbow into full flexion, as otherwise the gain of extension may occur at the expense of a loss of flexion.

Vigorous massage and forced movements are to be avoided, and are a potent cause of myositis ossificans.

Technique of Manipulation (Fig. 49).

We have already referred to the importance of an X-ray examination of a stiff joint, and this procedure applies with particular emphasis before any manipulation of the elbow-joint. In cases where minor adhesions are present, the long leverage is desirable, which is achieved by grasping the upper arm firmly in the lower third and the forearm in the region of the wrist; short, rapid movements of flexion and extension are then carried out. In the case of more dense adhesions, one hand grasps the back of the elbow and supports the olecranon process, which otherwise is liable to fracture, while the thumb of the same hand, by firm pressure on the head of the radius in the antecubital fossa, prevents luxation forwards of this bone. The other hand of the surgeon firmly grasps the forearm in the middle third. Then by slow, steady pressure,

rather than by any form of jerking movement, the resistance to flexion and extension is gradually overcome. The principle of gradually overcoming the obstruction to movement by a series of manipulations where adhesions are of a dense nature should, of course, be followed. The reason for this is that in such severe cases adaptive shortening of muscles and other structures has occurred, particularly on the side of flexion,



FIG. 49.—MANIPULATION OF ELBOW: FLEXION.

Note.—During extension, which is not illustrated, the surgeon's thumb presses upon the front of the radial head to prevent luxation forwards of the latter.

permitting movement only within a certain range. If, therefore, at one manipulation an attempt be made to restore full movement, a severe sprain may result from rupture of muscular fibres. In restoring full extension, it is important to bear in mind the normal "carrying angle."

Manipulation of Elbow—Illustrative Cases.—

CASE I.—A young lady fell from a tree, sustaining a dislocation of the left elbow associated with a partial fracture of

the internal condyle of the humerus. The dislocation was reduced almost immediately, and early movements instituted. No attempt was made temporarily to place the elbow in full flexion in the intervals of massage and movements, and the joint steadily became more and more stiff. Eleven weeks later the elbow was manipulated elsewhere, but again the position of full flexion was not insisted upon, and the elbow again became stiff.

On examination one month after the above-mentioned manipulation the left elbow was held at an angle of 135 degrees. Extension beyond this point was prevented by painful muscular spasm. Flexion was possible to an angle of 90 degrees, but beyond this was restricted by muscle spasm. Pronation and supination were complete. X ray showed no evidence of myositis ossificans, but evidence of slight previous injury to the inner condyle of the humerus. It was decided in this case to endeavour to restore movement gradually by at least two manipulations, retaining the elbow in as full flexion as possible as the position of rest after each manipulation.

First Manipulation.—Flexion and extension very carefully and gradually increased until limited by about 20 degrees. The elbow was flexed as fully as possible, but released daily for radiant heat, effleurage, and movements, particular attention being paid to active movements in the direction of extension.

Second Manipulation.—A week later, almost complete movement was obtained, and similar after-treatment followed. The position of rest in full flexion was retained for a fortnight, and at the end of this period almost complete and painless active movements were present, and have been maintained.

CASE II.—Mrs. W., ten months previously, fell on outstretched right hand. Slight transient pain and discomfort occurred in the right elbow-joint, and a week later she noticed a feeling of stiffness in the same joint and slight limitation of extension. The whole arm ached, particularly after use. The limb was immobilised for several weeks, but on attempting to use it again the same symptoms recurred. Immobilisation was again ordered, and altogether the limb was rested for many months. Tuberculous disease was suspected, but the X ray was normal.

On Examination.—There was no swelling of the joint and no enlargement of the articular ends. Pain was caused by full flexion and on extension, the latter movement being slightly restricted. Slight muscular wasting and tenderness upon the outer side of the joint were present, but there was no raised temperature over the joint. Adhesions following traumatic

synovitis were diagnosed, and manipulation was performed under gas followed by immediate re-education.

Result.—Rapidly cured.

The symptoms in this case were characteristic of many cases in which adhesions are present. Use of the joint causes pain and swelling, and immobilisation is ordered. Further use again gives rise to the same symptoms, and immobilisation is again ordered. This sequence of events is often spread over a very long period—sometimes years—and not infrequently, the medical adviser begins to suspect tuberculous disease. Manipulation by breaking down the adhesions which are the cause of the clinical picture usually results in rapid cure, and in the case mentioned above these adhesions could probably have been prevented by properly administered massage and movements.

(c) The Wrist-Joint.

Surgical Anatomy (Fig. 50).—A condyloid joint at which the lower articular surface of the radius with the triangular fibrocartilage form a concave surface which articulates with the convexity formed by the upper surfaces of the scaphoid, semilunar, and cuneiform bones.

An *articular capsule* surrounds the joint, and is strengthened by the following ligaments:

Anterior.—Is attached above to the anterior border of the lower extremity of the radius and to the anterior surface of the head of the ulna, and its fibres pass downwards and inwards, and are attached to the anterior aspect of the bones of the proximal row of the carpus.

Posterior.—Is attached above to the posterior border of the lower end of the radius, and its fibres also pass downwards and inwards to be attached to the dorsal aspects of the bones of the proximal row of the carpus.

Internal Lateral.—A rounded cord attached above to the styloid process of the ulna, and below to the inner surface of the cuneiform and to the pisiform.

External Lateral.—Is attached above to the styloid process of the radius, and below to the tuberosity of the scaphoid and to the trapezium.

Synovial Membrane.—Is loose and lax and lines the deep surface of the capsule. The synovial cavity does not communicate with that of the inferior radio-ulnar joint.

Movements (Fig. 51, *b* and *c*).—The following are permitted: flexion, extension, abduction, adduction, and circumduction.

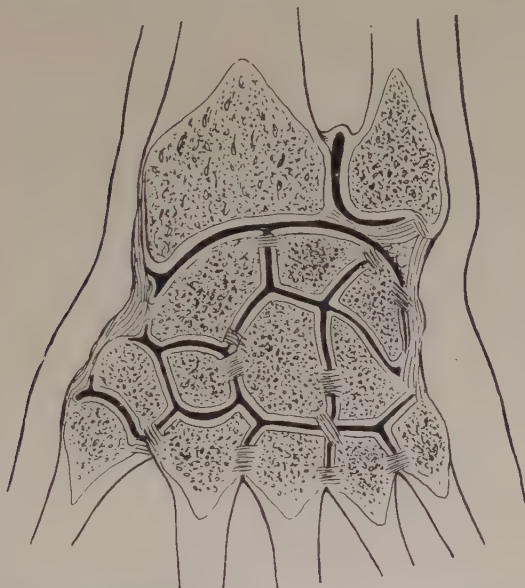


FIG. 50.—SECTION THROUGH WRIST, INFERIOR RADIO-ULNAR, CARPAL AND CARPO-METACARPAL JOINTS TO SHOW ARRANGEMENTS OF SYNOVIAL CAVITIES.

It must be remembered that in these movements the intercarpal and carpo-metacarpal joints participate to a certain extent.

Flexion (Fig. 52) is possible through 70 to 90 degrees with the fingers extended, and through somewhat less with the fingers flexed.

Extension (Fig. 53) is possible through about 65 degrees with the fingers extended, and to a somewhat greater degree

when the fingers are flexed. It is interesting to note that actually flexion at the wrist-joint proper is more limited than extension, but this is more than compensated by movement at the inter-carpal and carpo-metacarpal joints.

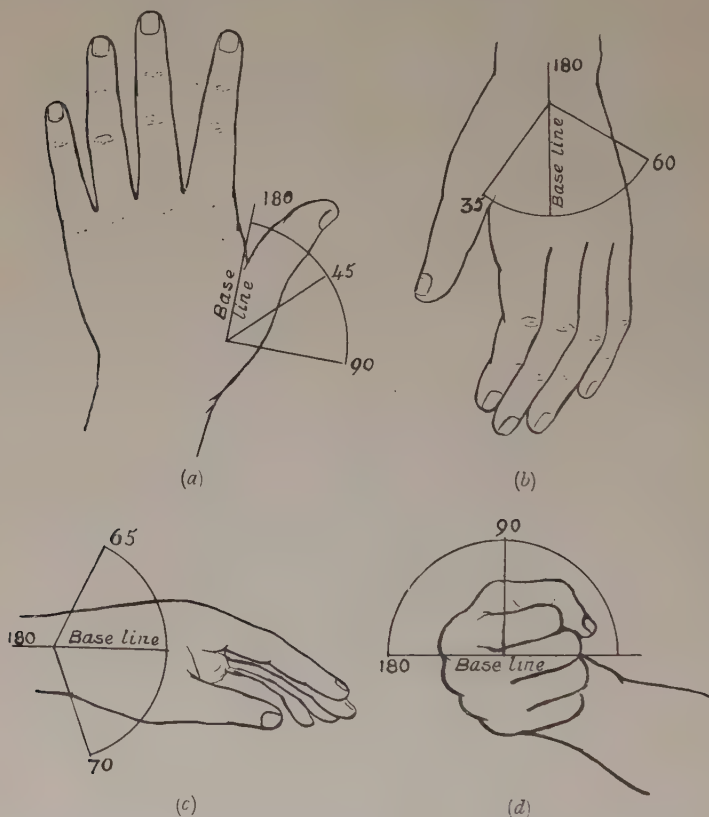


FIG. 51.—DIAGRAMS SHOWING: (a) RANGE OF EXTENSION OF THUMB; (b) ABDUCTION AND ADDUCTION OF WRIST; (c) FLEXION AND EXTENSION OF WRIST; (d) PRONATION AND SUPINATION OF FOREARM.

Abduction (Fig. 54), or radial flexion, is less free than—
Adduction (Fig. 55), or ulnar flexion, owing to the contact of the styloid process of the radius with the carpus.

Circumduction is a combination of these movements.

INFERIOR RADIO-ULNAR JOINT (Fig. 50).—At this joint the head of the ulna articulates with the lesser sigmoid cavity of the radius laterally, and with the triangular fibro-cartilage below.

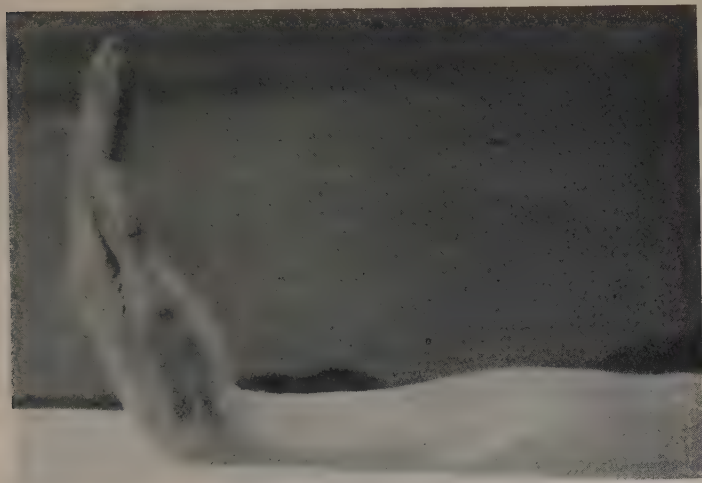


FIG. 52.—MOVEMENTS OF WRIST: FLEXION, WITH FINGERS PARTIALLY EXTENDED.

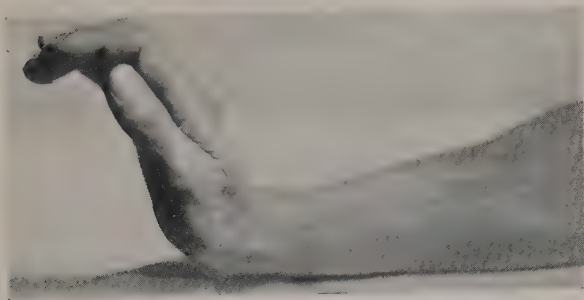


FIG. 53.—MOVEMENTS OF WRIST: EXTENSION.

Articular Capsule.—Is very weak proximally, but is strengthened in front and behind by accessory bands—the anterior and posterior radio-ulnar ligaments.

Triangular Fibro-Cartilage.—This is attached by its apex to a pit between the head and styloid process of the ulna, and by its base to the ulnar border of the lower articular surface of the radius. It is an important bond of union between the lower ends of the radius and ulna, and during pronation and supination its ulnar attachment is the centre of the movement, during which the lower end of the radius carrying the hand revolves around the lower end of the ulna. During this

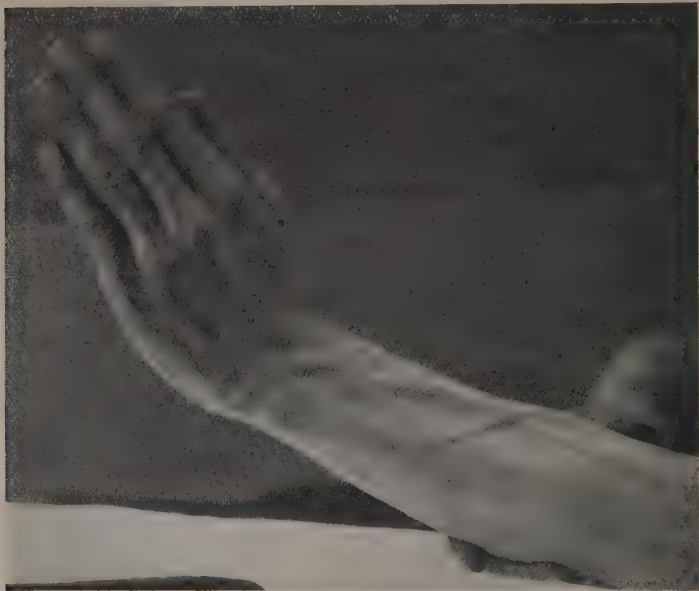


FIG. 54.—MOVEMENTS OF WRIST: ABDUCTION.

rotation there is also a certain amount of antero-posterior gliding movement of the radius upon the ulna. Both surfaces of the triangular cartilage are covered with synovial membrane.

Synovial Membrane.—Is very lax, and bulges above between the radius and ulna in the form of the recessus sacciformis.

Movements at Radio-Ulnar Joints (Fig. 51, *d*).—At these joints the movements of pronation and supination take place,

the axis of movement passing through the head of the radius and the apex of the triangular fibro-cartilage. In full supination the radius and ulna are parallel, and the thumb is directed outwards. If we exclude shoulder movement, pronation—during which the radius crosses over the ulna so that the thumb is directed inwards—is possible through an arc of



FIG. 55.—MOVEMENTS OF WRIST: ADDUCTION.

about 180 degrees. Quite frequently, however, the normal range of rotation does not exceed 160 degrees. If, however, we include rotatory movement at the shoulder-joint, starting from the fully supinated position the forearm can be rotated through some 270 degrees until the palm and flexor surface of the forearm are directed outwards.

Manipulation of the Wrist.

Prevention of Deformity.—In any marked inflammatory condition of the wrist, the hand tends to assume a flexed position similar to that seen in “drop-wrist.” When the hand is allowed to become fixed in such a position, the thumb and fingers, as Sir Robert Jones has emphasised, are placed at a serious functional disadvantage, and the usefulness of the hand markedly impaired. During such conditions, the position



FIG. 56.—MANIPULATION OF WRIST: DORSIFLEXION.

of rest should be one of dorsiflexion maintained by a “cock-up” splint, which may be removed periodically for massage and movements.

Among the commonest causes of stiffness of the wrist are fractures in the region of the joint, particularly Colles’s fracture of the radius, in which there has been prolonged immobility, neglected sprains, contusions, synovitis and chronic arthritis, and contraction by scar tissue, in which may be included Volkmann’s ischæmic contracture. In many of these cases

it should be remembered that adhesions are also present in the carpal and inferior radio-ulnar joints, and in the sheaths of the flexor or extensor tendons, or, indeed, may be confined to the latter. When the inferior radio-ulnar joint is involved, there is interference with pronation and supination, in addition to the movements of the wrist-joint proper.

Manipulative Technique.—The surgeon with one hand takes a firm grip of the patient's hand, and with his other hand grasps the forearm just above the wrist. It will be found an advantage if, when extending the wrist, the surgeon grasps the forearm in such a manner that the palm of one hand lies upon the extensor surface of the patient's forearm and the palm of the other hand is in contact with the patient's palm (Fig. 56). In producing flexion the position of the hands is reversed, so that the hands grasp the flexor surface of the forearm and the dorsum of the hand respectively. Lateral, rotatory, and circumductory movements are next carried out by grasping the patient's hand in the hand-shaking position. During these movements, traction should be exercised. In severe cases of stiffness, such as we so often see in neglected cases of Colles's fracture, much may be done by adopting the plan of a series of manipulations separated by short intervals, during which the increased movement is consolidated.

Manipulation of Wrist—Illustrative Cases.—

CASE I.—H. W. P., aged 16, stumbled over a football and fell on the back of the right wrist. Marked pain, swelling, and bruising of the dorsum of the wrist followed, and an X ray showed a fracture of the ulnar styloid. A "cock-up" splint was applied, and kept on for three weeks without being removed. After removal of the splint, massage was ordered.

On examination, five weeks after the injury, some swelling of the wrist was present, with localised tenderness over the styloid process of the ulna. All movements of the wrist were slightly restricted and painful, but pronation and supination were both restricted by 25 per cent. Manipulation was performed under gas, during which adhesions were heard to give way and full movement obtained. Immediate radiant heat, massage, and movements were instituted, by which means the increased movement obtained was consolidated.

CASE II.—Mrs. — had an attack of rheumatic fever, after which the right wrist-joint became affected with arthritis. She was treated by radiant heat and massage, but no attempt was made to prevent deformity, and the wrist became fixed in 45 degrees of flexion. Preparations were made for an open operation, but while under the anæsthetic it was found that full movement could be restored by manipulation alone. The hand was temporarily fixed in a “cock-up” splint in full extension. Movements were commenced after twenty-four hours, but the splint worn in the intervals for a week to maintain extension. The function of the hand was in consequence considerably improved.

CASE III.—T. P. strained right wrist playing golf. Complained of pain on dorsum of hand, and weakness of grip.

On Examination.—Slight swelling and tenderness over common extensor sheath on dorsum of hand. Full palmar flexion of wrist, particularly with the fingers flexed into palm, caused aggravation of the pain. A diagnosis of slight adhesions in the extensor sheath was made. An anæsthetic was refused, but the fingers were flexed into palm and the wrist smartly flexed, while firm thumb pressure was maintained upon the previously tender spot. The patient was immediately cured.

CASE IV.—D. Eight months previously, his horse stumbled and he was thrown, the greater part of the impact being borne by the left outstretched hand. A Colles's fracture resulted, which was set under an anæsthetic, a Carr's splint being applied and early massage and movements instituted. Sixteen days later, owing to the overturning of an oil lamp, the splint caught fire, and the forearm was burned. Owing to this accident, massage and movements were discontinued for three weeks. At the end of this period, massage and movements were resumed, but it was found that marked pain and limitation of flexion of the wrist of an obstinate nature persisted. Prolonged local treatment having no beneficial effect, and as X rays showed the fracture to be in good position, manipulation was performed under a general anæsthetic, and massage and movements started the same day.

Result.—Almost complete movement obtained, and the pain, which had been obviously due to adhesions, disappeared.

In some neglected cases of Colles's fracture with malposition, it may be necessary to break down the band of union by manipulation and to reset. This method of treatment is only indi-

cated while the callus is still comparatively soft: in later cases, osteotomy may be necessary. In neglected cases, in addition to the stiffness of the wrist and inferior radio-ulnar joints, there may be stiffness of the fingers. If this stiffness is marked, a series of manipulations is sometimes necessary and temporary splintage in the corrected position should be adopted. The splints must be removed daily for massage and movements.

(d) The Thumb.

Surgical Anatomy (Fig. 50) —*Carpo-Metacarpal Joint*.—The saddle-shaped surface of the trapezium articulates with a corresponding surface of the base of the first metacarpal bone, the joint being surrounded by a capsular ligament.

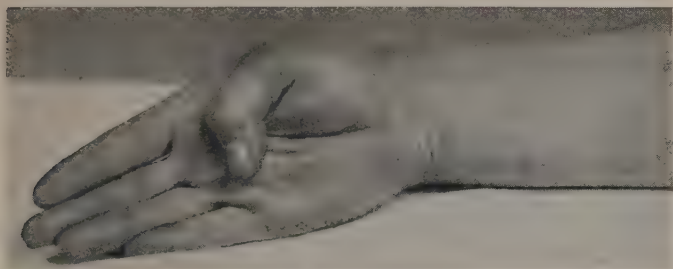


FIG. 57.—MOVEMENTS OF THUMB: FLEXION.

Metacarpo-Phalangeal Joint.—Differs in no material degree from that described in the case of the fingers.

Interphalangeal Joint.—Similar to those occurring in the fingers.

Movements of the Thumb.—The movements of the thumb are really quite simple if thoroughly mastered, but many fail to grasp the difference between such movements as abduction and extension of the thumb, or to realise the range of movement at the different joints. It is hardly necessary to state that from medico-legal and other aspects, the movements of the thumb are of the greatest importance.

Carpo-Metacarpal Joint of Thumb.—(a) Flexion is the movement inwards of the first metacarpal across the palm (Fig. 57).

(b) Extension is the movement outwards in the same plane (Figs. 51, *a*, and 58).

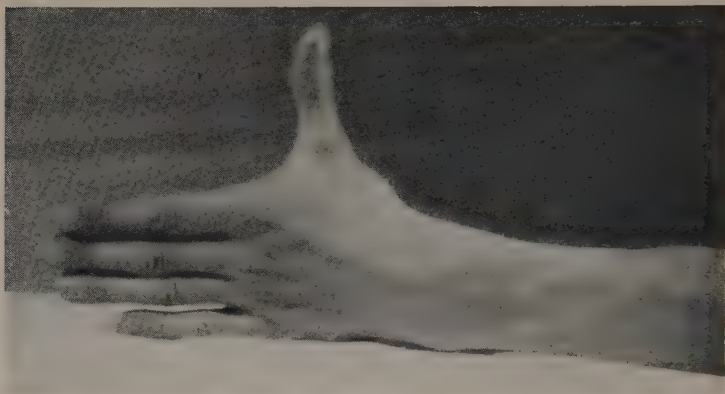


FIG. 58.—MOVEMENTS OF THUMB: EXTENSION.



FIG. 59.—MOVEMENTS OF THUMB: ABDUCTION.

(c) Adduction is the movement of approximation of the first metacarpal towards that of the index finger.

(d) Abduction is the movement away from the metacarpal bone of the index finger in the same plane (Fig. 59).

(e) Opposition is a combination of flexion, adduction, and internal rotation, whereby the first metacarpal with its muscles, which constitute the ball of the thumb, is carried forwards and inwards, so that the thumb when slightly flexed can touch the tips of the slightly flexed fingers (Fig. 60).

Metacarpo-Phalangeal Joint of Thumb.—Flexion is only possible through about 45 degrees (Fig. 57). Extension is possible through the same angle until the phalanx and metacarpal bone are in the same straight line.

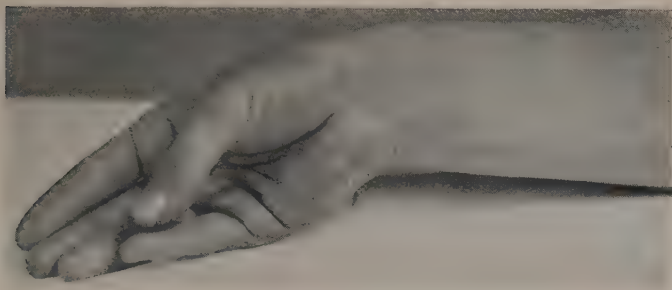


FIG. 60.—MOVEMENTS OF THUMB: OPPOSITION.

Interphalangeal Joint of Thumb (Fig. 57).—Flexion through 90 degrees. Extension through similar angle until proximal and distal phalanges are in line.

(e) The Fingers (Fig. 61).

Metacarpo-Phalangeal Joints.—Condylloid joints in which the head of the metacarpal articulates with the base of the proximal phalanx.

The Articular Capsule is deficient dorsally, where its place is taken by the expanded extensor tendon. It is strengthened laterally and on the palmar surface by the lateral and palmar ligaments respectively. The former are attached to the sides of the metacarpal head and to the lateral aspect of the base of the proximal phalanx, while the latter, which is strong and fibro-cartilaginous, is attached firmly to the palmar surface of the base of the phalanx, but loosely to the neck of the cor-

responding metacarpal bone. Its palmar surface is in contact with the flexor tendons and their sheaths. Flexion at the metacarpo-phalangeal joints of the fingers is possible through 90 degrees (Fig. 62). Extension through a similar range,



FIG. 61.—SECTION OF FINGER, SHOWING METACARPO-PHALANGEAL AND INTERPHALANGEAL JOINTS AND FLEXOR SYNOVIAL SHEATH.

and in most cases, a few degrees of hyperextension are possible at this joint.

Interphalangeal Joints.—Hinge-joints. They present a capsule, collateral and palmar ligaments, as in the metacarpo-phalangeal joints. At each joint flexion and extension occur through 90 degrees.

Manipulation of Stiff Fingers.

Stiffness of a finger is liable to follow fracture of metacarpal bone or phalanx, suppurative processes in the finger, especially where involving the tendon sheaths, chronic arthritis and prolonged immobility.

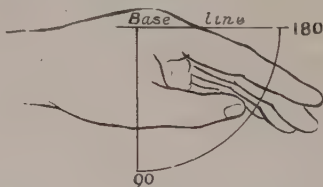


FIG. 62.—MOVEMENTS AT METACARPO-PHALANGEAL JOINTS.

As in so many other situations, a great many stiff fingers might have been prevented by more enlightened treatment. The fallacious and widely held teaching that prolonged immo-

bility of a joint in proximity to a fracture, does not lead to serious stiffening of the joint is, of course, responsible for those cases following fracture. A suppurative process can often be prevented from involving the tendon sheaths by early incision, and prolonged immobility of the fingers should be avoided. A good example of a most obstinate type of stiffness of the fingers from this cause is that seen after a neglected Colles's fracture. If immobility is practised for too long a period, a stiffness of the wrist, carpal, metacarpo-phalangeal, and interphalangeal joints is apt to develop, which may prove very difficult to treat, and may require a series of manipulations.

Manipulative Technique.

In manipulating the fingers, it should be borne in mind that the heads of the metacarpal bones constitute an arch, and that a certain amount of movement is possible between the heads of adjacent metacarpal bones. Adhesions occasionally occur between the metacarpal heads, and interfere with the normal gliding movement. In breaking down these adhesions, the distal end of each of the affected metacarpal bones should be grasped with the surgeon's thumb and forefinger, and smartly moved backwards and forwards upon each other. In the case of the metacarpo-phalangeal joints, it is often assumed that the movements of flexion and extension are the only ones possible, and lateral movements of abduction and adduction and the movements of rotation and circumduction are apt to be forgotten.

It is important to realise also that the metacarpo-phalangeal and interphalangeal joints are not pure hinge-joints, but that during flexion and extension a gliding movement of the base of the phalanx occurs.

In manipulation of the metacarpo-phalangeal and interphalangeal joints, the bones on the proximal and distal sides of the joint are firmly grasped between the fingers and thumbs of the surgeon and traction exerted. In cases of somewhat dense adhesions a firm steady pressure is exercised, whereas in the slighter types of adhesions more rapid movements are

performed. In performing flexion of the digits the wrist should be simultaneously extended and lateral movements of the affected joint first performed. During flexion, the phalanx must be made to glide forwards simultaneously, by exercising pressure from behind forwards upon its base. In cases in which dense adhesions have been present it is wise to bandage the finger or fingers in full flexion for twenty-four hours. In other cases re-education is to be commenced immediately.

For the treatment of stiff and contracted fingers due to shortening of tendons, such as is seen in Volkmann's ischæmic contracture, a textbook of orth pædic surgery should be studied.

CHAPTER VII

MANIPULATION OF THE SPINE

Osteopathy.—Before discussing the question of manipulation of the spine, a brief reference must be made to “osteopathy.”

This is a system of treatment emanating from America. The underlying theory is that all disease is due to interference with the blood-supply, and that this interference is caused by pressure upon the vaso-motor system in the region of the spine. This pressure is said to be due to minor displacements or “subluxations” of vertebræ—the “osteopathic lesions.” The level of the “osteopathic lesion” depends upon the organ affected. For instance, an ulcer of the stomach, gastric carcinoma, or a dilated stomach are all considered due to an “osteopathic lesion” at one particular site, and the treatment by spinal manipulation would be similar. Conditions affecting the kidney, whether inflammatory or new growth, whether due to calculus or displacement, are similarly due to an “osteopathic lesion” at another level, and the treatment of all these varied conditions would be similar. It is interesting to note that defective vision and deafness are also treated by manipulation of the spine, although anyone with the most elementary knowledge of anatomy must be aware that the nerves of these organs do not originate in the spinal cord, neither do they pass through the intervertebral foramina. No evidence that will stand scientific scrutiny has so far been brought forward by osteopaths to support their theories. If the theories were harmless, one could safely ignore the cult and allow it to die a natural death, but unfortunately they are in many cases dangerous. Many osteopaths pay little or no attention to diagnosis, and patients with malignant disease or other serious conditions often waste precious time in such treatment, while the condition from which they are suffering is rapidly getting

beyond useful medical or surgical intervention. There are many cases recorded where appendicitis and appendix abscess have been treated osteopathically with fatal results. The danger of the osteopathic theory is further shown by the fact that some osteopaths claim to cure acute infectious diseases, and hold that these disorders are due to interference with the circulation of the blood by "subluxated vertebræ." One has personally seen many unfortunate results following osteopathic treatment. In one, osteopathic manipulation of the spine and pelvis was given to cure flat feet in a young woman ! As a result she became a hopeless neurasthenic on the borderland of insanity, and with a fixed delusion that her pelvis had been displaced. In another case, a patient with inoperable cancer of the throat submitted to a series of manipulations of his cervical spine.

A medical friend, with generalised rheumatoid arthritis, was told that his tenth dorsal vertebra was one-twelfth of an inch out of position, and the osteopath proposed to replace it by a series of manipulations. When my friend innocently inquired how this could possibly have any effect upon his arthritis, the osteopath with a sweeping gesture pointed to a well-filled bookcase of osteopathic works. "Ah," said he, "you must read the literature." Literature forsooth !

One has also encountered several cases where manipulation of the neck has brought about severe injury to the ligamentous, muscular, and tendinous structures therein.

A clergyman submitted to a large series of manipulations of his neck by an osteopath for dyspeptic symptoms. At each manipulation it was alleged that displacement was corrected, and a "click" was certainly heard ! As his dyspepsia was not improved by twenty manipulations of his neck, he consulted a medical man, who prescribed measures which rapidly cured the trouble. The symptoms of severe sprain of the neck muscles that persisted for a considerable time, served to remind him of his credulity and of the methods of many osteopaths. An aged lady submitted to a sudden and violent manipulation of her neck for slight rheumatic symptoms. Although her death, which occurred some months later, was not directly

attributable to the violent wrenching, yet in many ways her decease was a happy release from the agonising and intractable pain that followed this "treatment."

Such examples are seen almost daily by any busy surgeon and could be multiplied indefinitely.

It is a melancholy reflection that the law permits such abominable and dangerous practices.

Yet in justice it must be said that there are osteopaths who do not hold such extreme views and whose methods are less dangerous, and that sometimes they seem to effect cures in cases that have defied more traditional methods. These cases fall into two groups, both of which really belong to the domain of manipulative surgery proper. In the first group are the patients whose symptoms are actually located in the spinal column or back, and in whom the alleviation or cure may not unreasonably be ascribed to the breaking-down of some adhesion in ligament, muscle, or aponeurosis, or to the rectification of some minor displacement. In the second group, are the patients whose symptoms are not actually located in the spine but elsewhere, which symptoms, however, are principally of a functional nature. The theory of the osteopath impresses the lay-patient by its delightful simplicity—"a bone is out of place and is interfering with the blood-supply." The simplicity of the theory, the conviction with which it is uttered, and the actual treatment itself, all act by powerful suggestion, and the osteopath is rightly credited with a cure, although his own explanation of its occurrence is erroneous.

Chiropractic is another cult somewhat similar to osteopathy, but based upon even more unscientific evidence. The chiropractors assume that all diseases and deformities are due to displacements of vertebræ causing pressure upon intervertebral nerves, which pressure causes interference with the normal flow of "vital force" from the spine to various parts of the body.

A recent definition of chiropractic is: "A system of adjustment, consisting of palpation of the spinal column to ascertain vertebral subluxations, followed by the adjustment of them by hand, in order to relieve pressure upon the nerves at the inter-

vertebral foramina, so that nerve force may flow freely from the brain to the rest of the body." Unfortunately for this theory, it is anatomically impossible for such pressure to occur without gross dislocations or displacements which would give rise to paralysis and other serious signs and symptoms, and which could be demonstrated by X-ray examinations. Furthermore, the diameter of the intervertebral foramen is quite twice as great as that of the nerve occupying it.

Space will not permit mention of the methods and training in many of the osteopathic colleges in America. In most cases the training is a farce. Attention has recently been drawn to this scandal in a recent Presidential Address before the Medical Society of London, which should be read by all interested in the subject. It is clear that another determined attack will be launched by the osteopaths ere long for State registration and recognition in this country. What should be the attitude of the medical profession towards this menace? **We owe it to the public to oppose, with the utmost vigour, any official recognition of osteopathy,** for the public would interpret even a limited form of State recognition as a licence to diagnose and treat all forms of injury and disease, and the results would be disastrous.

It is sometimes argued that the osteopaths should be registered and permitted to practice under medical supervision. The adoption of this suggestion would introduce endless abuses, and it is obviously more desirable that if there be aught of good in osteopathy it should be practised in this country by persons who have received a general training in and who possess a qualification in medicine and surgery recognised by the General Council of Medical Education.

It is clear that there is a great difference between manipulative treatment proper, which is based upon a rational and logical basis and is a most valuable therapeutic measure, and osteopathy and chiropractic, which are not so based.

Surgical Anatomy.—A brief reference to some special points in the surgical anatomy of the spine, and to the normal range of movement possible in the different regions thereof, is an indispensable preliminary to any discussion of the conditions

therein which are amenable to manipulation and of the manipulative technique involved. For the general anatomy of this complicated region, the reader is referred to the textbooks of anatomy. As, however, the latter but rarely give any reliable information upon the movements of the spine, a brief account will be given, in which we shall follow the admirable observations of Lovett.*

The spine is an elastic column which owes much of its strength to the fact that although it consists of a number of vertebræ, the degree of movement between individual bones is slight, and yet the sum of movement is considerable. The arrangement of the spine in a series of curves also gives far greater strength to the spine, for a vertical force is decomposed by the curves. The weakest mechanical point in the spine is where the comparatively rigid dorsal spine meets the more mobile lumbar portion.

The prolonged nature of the disablement following many spinal injuries is not difficult to understand, if we bear in mind the extreme complexity of this region, and the multiplicity of the joints, ligaments, and muscles connected therewith. The important fact must never be overlooked that the spinal cord traverses the neural canal of the vertebræ and that important nerves emerge therefrom, and consequently injuries of the spine are liable to be complicated by involvement of either the spinal cord itself or of the emerging nerve roots. Furthermore, it is probably owing to the presence of the spinal cord that injuries of the spine are particularly liable to be followed by functional disorder.

Musculature of the Back.—The apparently complicated arrangement of the muscles of this region may be partly simplified by dividing them into separate layers. Of these, the first two belong to the upper extremity, including the shoulder girdle, and the fourth and fifth layers are more truly spinal.

First Layer.—Trapezius, latissimus dorsi.

Second Layer.—Levator anguli scapulæ, rhomboids.

* "Lateral Curvature of the Spine and Round Shoulder," by R. W. Lovett, fourth edition. (H. K. Lewis and Co.)

Third Layer.—Serratus posticus superior and inferior, splenius colli and capitis.

Fourth Layer : Sacral and Lumbar Regions.—Erector spinæ.

Thoracic Region.—Ilio-costalis, accessorius, longissimus dorsi, spinalis dorsi.

Cervical Region.—Cervicalis ascendens, transversalis cervicis, trachelo-mastoid, complexus, biventer cervicis, spinalis colli.

Fifth Layer.—Semispinalis dorsi, semispinalis colli, multifidus spinæ, rotatores spinæ, interspinales, extensor coccygis, intertransversales, rectus capitis posticus major and minor, superior and inferior oblique.

At first sight, such a bald recital of the different muscles as given in textbooks of anatomy, is confusing and even irritating. Let us, therefore, endeavour to simplify the matter as follows:

Fourth Layer.—The “erector spinæ” has a strong tendinous origin from the iliac crest, the sacrum, and the lumbar spines, and divides into three muscular masses.

The outer—the sacro-lumbalis, with its prolongations, *musculus accessorius* and *cervicalis ascendens*—is attached to the **angles of the ribs**.

The middle—the *longissimus dorsi*, with its prolongations, *transversalis colli* and *trachelo-mastoid*—is attached to the **transverse processes of the vertebræ**.

The inner—the *spinalis dorsi*, with its prolongations—is attached to the **spinous processes of the vertebræ**.

Fifth Layer.—The greater part of the muscles constituting this layer form a mass filling up the space between the transverse and spinous processes of the vertebræ, and the general direction of the fibres is oblique. The *intertransversales* pass between the transverse processes of adjacent vertebræ and the *interspinales* between the spinous processes. The *semispinalis dorsi* and *colli*, the *multifidus spinæ*, and the *rotatores spinæ* pass obliquely between the transverse processes and the vertebral spines. The more superficial bundles pass over several vertebræ, while the deeper bundles pass between adjacent vertebræ.

Lumbar Aponeurosis.—In the opinion of the author, many

cases of prolonged disability are caused by injuries of this aponeurosis, or, rather, by injudicious treatment of such injuries by prolonged rest, until adhesions and scar tissue have formed in and about this structure or its extensions.

Ligaments.—These are exceedingly numerous, and for their detailed description, a textbook of anatomy should be studied. It will suffice to mention that not only are there ligaments which stretch between the vertebral bodies (anterior and posterior common ligaments and intervertebral discs), but also ligaments connecting the articular processes, laminae, spinous and transverse processes. Further, there are ligaments connecting the heads of the ribs with the bodies of the vertebrae, and others connecting the necks and tubercles of the ribs with the transverse processes. In the upper cervical and lumbo-sacral region, there are other important ligaments having special functions.

Spinal Surgical Landmarks.—A few of the most important and essential of these are given. Five minutes spent in committing them to memory will be amply repaid.

Root of Spine of Scapula.—Interval between third and fourth dorsal spines.

Inferior Angle of Scapula.—Interval between seventh and eighth dorsal spines.

Highest Point of Iliac Crest (Interiliac Plane).—Fourth lumbar spine.

Posterior Superior Iliac Spine.—Second sacral spine.

Spinal Cord Ends.—First lumbar spine (transpyloric plane).

Spinal Theca Ends.—Third sacral spine.

Movements of the Spine.—The actual movements in the spine itself are really less than might at first sight be assumed on observing full forward flexion, for a considerable amount of the apparent movement is pelvic, and takes place at the hip-joints, and some of the movement occurs between the skull and the spine.

If desirous of ascertaining the actual movements of the spine itself, some means must be taken of fixing the pelvis, and correction must be made for movement at the occipito-atlantal joint. Similarly, if exercises and passive manipula-

tions are performed which are intended to act upon the spine alone, the pelvis should be fixed.

The actual movements may be divided into flexion, extension, and a complicated movement—lateral flexion + rotation. There is no such movement as a pure lateral flexion, for a certain amount of rotation inevitably accompanies this. Similarly, rotation is always accompanied by a certain amount of lateral flexion. It is important to remember, however, that there is a variation in the degree of the rotatory and the lateral flexion elements respectively in the various regions of the spine. The nature of the movements is largely influenced by the shape and direction of the articular surfaces.

Flexion (Bending Forwards).—This movement is most marked in the lumbar region, and is possible until the normal forward convexity is practically obliterated. The movement is more marked, therefore, in the lower part of the lumbar region. In the cervical region flexion can occur until the physiological curve is obliterated. Most of the apparent movement of flexion really occurs at the occipito-atlantal joint. In the dorsal region, forward movement is very slight, but the normal convexity backwards is slightly increased.

Extension (Bending Backwards).—This movement is most free in the lumbar and two lower dorsal vertebræ. Very little movement in this direction occurs in the remainder of the dorsal region, and in the neck the physiological curve can be increased slightly, the greater part of the apparent movement occurring at the occipito-atlantal joint.

Lateral Flexion and Rotation—(a) *Lateral Flexion Element.*—As we have seen, this movement is always combined with a certain amount of rotation, but the lateral flexion factor is most marked in the lumbar zone. It is interesting and important to note that when the spine is flexed, lateral flexion occurs at a higher level in this region, and at a lower level when the spine is hyperextended.

(b) *Rotatory Element.*—In striking contrast to the lateral flexion element, the rotatory element is almost negligible in the lumbar region, but is most free in the dorsal and cervical region. It is not difficult to understand why this should be

so, if the reader will glance at the shape of the articular processes in the different zones. Here, again, when the spine is flexed, rotation occurs at a higher level than in the erect position, but when the spine is hyperextended, at a lower level. Thus, by altering the degree of flexion or extension of the spine, the effect of rotation and lateral flexion can be brought to bear on successive spinal regions.

Indications for Spinal Manipulation.—The most frequent indications for manipulation are those cases in which adhesions have followed either toxic or infective conditions, or ligamentous or muscular injuries, following contusion, or some sudden forcible movement. These injuries naturally occur most frequently in the more movable cervical and lumbar regions. Some of these cases are associated with minor forms of osseous lesion, such as fracture of a transverse, articular or spinous process. The more severe forms of injury, such as compression-fracture, fracture-dislocation, or severe ligamentous injury, all of which are usually associated with more or less serious involvement of the spinal cord or nerve roots, will not be considered here, as the field for subsequent manipulation in such severe cases is a very limited one. Other indications for manipulation include functional or hysterical conditions of the spine (the so-called "railway spine"), except when the patient, as is usually the case, is claiming compensation, and therefore any improvement in his state does not accrue to his financial advantage.

One-sided dislocations, which are confined to the cervical region, are conditions which urgently demand manipulative replacement.

It is probable that many cases which simulate unilateral displacement of a cervical articular process, and in which the X rays are negative, are due to displacement of a tendon of one of the deeper neck muscles.

Spinal Adhesions.—In the lumbar region, such injuries are extremely common, and may occur after some severe and sudden movement. If this movement was of the nature of flexion or rotation, both sides are usually involved, whereas if a sudden movement of lateral flexion occurred, the symptoms may be unilateral. This condition is sometimes known

as "traumatic lumbago," and is a most frequent cause of litigation and actions for compensation, and constitutes what is often an extraordinarily difficult problem. There is often a complicated mixture of an organic element, a genuinely functional element, and an element of exaggeration of symptoms, or, what is equally difficult to treat, such a mental attitude on the part of the patient that he seems unwilling or incapable of co-operating in treatment, or of ever admitting that he is better. All of these factors may be present in varied proportions in different patients, or in the same patient at different times. These cases are among the most difficult in the whole realm of surgery, and call for great experience and surgical intuition in diagnosis, and infinite patience and resource in treatment. In compensation cases, an attempt should be made to appeal to the better side of the patient, and to argue that it is more to his moral and physical advantage to get better than to extract the maximum amount of compensation at the expense of a disability which may, owing to his attitude, become a life-long burden.

The whole picture is made infinitely more difficult and complicated by the fact that it is often well-nigh impossible to distinguish between "traumatic lumbago" and what, for want of a better term, we may call "rheumatic lumbago." The latter may come on with almost startling suddenness, and not infrequently, even in severe cases, there is a history of a slight twist or some other minor form of injury, which in some mysterious, and as yet little understood, way seems to light up an attack of this nature. Owing to the sudden onset of acute pain without known cause, the Germans call the condition *hexenschuss* ("witch's shot"). It is clear that no sharp line of demarcation can be drawn between the two varieties of lumbago, but it is only when there is a clear history of some severe trauma, that the symptoms should be attributed to an "accident" in the legal sense.

The author thinks it probable that in some of these cases, the symptoms are due to "locking" in a position of normal motion occurring between the articular processes of two lumbar vertebræ.

In the cervical region such injuries are particularly liable to follow falls upon the head in the hunting-field or in diving. In this region, also, we must be careful to distinguish between traumatic myositis following contusion or sprain, rheumatic myositis, which may occur very suddenly without definite history of injury, and the rarer condition, unilateral dislocation or possibly tendinous displacement. In all, the position assumed is usually one of "wry-neck," the head being laterally flexed towards the affected side and rotated to the opposite side. An X-ray examination will decide whether a dislocation is present, and the presence or absence of a definite history of injury will assist in differentiating "rheumatic myositis" from the other conditions.

Prevention of Adhesions in the Spine.—In the treatment of injuries of slight or moderate degree affecting the ligaments or musculature of the spine, and of rheumatic affections of the same structures, the author has found by experience that those cases in which judicious rest to the affected region is combined with daily massage and gentle movements from the first do incomparably better than those in which treatment by prolonged and uninterrupted rest combined with fixation by strapping is utilised. If the massage and movements are skilfully performed the patient almost invariably expresses a sense of great relief. It is inconceivable that measures which relieve pain and make the patient more comfortable can be harmful, yet it is surprising how seldom these measures are intelligently employed from the first, and how often they are rendered impossible by a rigid cuirass of strapping. It seems clear that if early massage and gentle movements were employed from the first we should see far fewer cases of painful disability of the back due to adhesions.

Diagnosis.—The most characteristic symptoms are pain and limitation of some particular movement, either of flexion, extension, lateral bending, or rotation. Tenderness is usually present at the site of the adhesions, and is often associated with localised muscle spasm. For instance, in the case of adhesions affecting one lumbar region, the erector spinæ of that side is sometimes spasmodically contracted. A certain amount of

deformity may be present, as an attitude is involuntarily assumed which prevents stretching of the contracted structures. In doubtful cases, X-ray examination should always be made to rule out of court the possible presence of tuberculous disease of the spine, whether active or quiescent. In the presence of such evidence, manipulation is absolutely contra-indicated, and may be followed by disaster.

Manipulative Technique.—To manipulate the lumbar spine, the patient lies upon his back upon the couch. The thighs are fully and simultaneously flexed upon the abdomen by the surgeon and his assistant, the pelvis rotates, and the lumbar spine is thus flexed. In the production of lateral bending, the dorsal region is fixed by an assistant or by a stout band, and the thighs remaining flexed, the surgeon grasps the pelvis or thighs and gradually overcomes the obstacle to free lateral movement.

To overcome the limitation of extension, the patient is placed in the lateral position, and while the dorsal region is fixed, the pelvis or thighs are grasped, and by rolling the pelvis, full extension is obtained. In some cases the patient may be placed in the sitting position, and the surgeon, placing one hand in the lumbar region to act as a fulcrum, with the other hand forcibly pushes the dorsal region backwards so that hyperextension is obtained.

Cervical Region.—The patient's head is made to project beyond the end of the operating table, the surgeon grasps the occipital region with one hand, and places the other hand upon the patient's forehead. Very gently, carefully avoiding the slightest degree of force, and simultaneously applying slight traction, the movements of flexion, extension, lateral bending, and rotation are then performed. Any tender area in the neck is afterwards subjected to firm kneading. The principle of immediate massage and exercises is followed after any spinal manipulation, and, as we have already emphasised in connection with the articulations of the limbs, should never be neglected if we desire a rapid and complete recovery.

Illustrative Case.—

The patient, aged 44, complained of acute pain in the lower part of the back which had been present for three weeks. He stated that he had been subject to frequent similar attacks of "lumbago" all his life, and for many years had walked badly, with the trunk inclined towards the left side. Beyond an attack of typhoid fever when a boy, general health had been good.

On Examination.—Scoliotic curve of moderate degree involving lower dorsal and lumbar regions, with convexity towards right side. Definite spasm of both erector spinæ muscles in lumbar region—more pronounced on the left side. Forwards flexion in lumbar region markedly restricted and painful, also lateral flexion towards the right side. Musculature of back ill developed and weak. On lying; marked pain was caused by full flexion of the thighs, and Kernig's sign was present on both sides. X ray showed no abnormality beyond slight scoliosis. Patient had never been able to lead a very active life owing to the back condition.

Diagnosis.—Adhesions in left lumbar and in lumbo-sacral regions causing recurrent attacks of "lumbago" and associated with defective spinal mechanics, weak musculature, and probably a certain functional element—*i.e.*, the typical spinal syndrome and vicious circle. Manipulation was performed with gratifying results. Pain was immediately and greatly relieved, and after a few weeks of massage and Swedish remedial exercises, completely disappeared, and there has been no recurrence of lumbago. He has an erect bearing, and has been able to take up an active athletic life.

Functional Disabilities of the Spine.—In these cases manipulation is performed for its psychological effect. The patient has in all probability been told by countless persons that there is "nothing wrong" with the spine, whereas we must remember that a functional condition is very real to the patient. It is in this type of case that the bone-setter's "bone out of place," which he proceeds to "replace" by manipulation, has a psychological effect which we cannot ignore. Whatever explanation we give, we must convince the patient that we are going to cure the condition by manipulation. This should be short, preferably under gas and oxygen anæsthesia, and re-education and suggestion are imme-

diately carried out not only by the surgeon, but by everyone with whom the patient comes in contact.

Unilateral Dislocations of Cervical Vertebrae.—These accidents, although not very common, occur with sufficient frequency to demand a knowledge of their reduction by every practitioner. They may occur after some comparatively trivial accident. The head is held in a distinctive manner, being laterally inclined towards the affected side and rotated to the opposite side. The inferior articular process of the upper vertebra usually becomes displaced in front of the superior articular process of the lower vertebra. In some cases, there is detachment of an articular process. A less severe type of injury may be encountered, in which the articular process of the displaced vertebra rests upon the edge of the corresponding process of the vertebra below. There is thus no actual interlocking, and in this type of lesion the patient's head may be laterally inclined towards the opposite side and only slightly rotated. An X-ray examination, which should never be omitted in any doubtful case of injury to the neck, will reveal the type of lesion present.

Reduction.—Traction followed by rotation backwards on the side of dislocation, or lateral flexion towards the uninjured side followed by rotation backward on the affected side, are usually efficacious, provided this treatment be carried out at the earliest possible moment.

After-Treatment.—In cases of subluxation or unilateral dislocation unassociated with cord symptoms, immediate massage and gentle movements may be instituted. Where, however, fracture of an articular process has coexisted, a short period of immobilisation in a well-fitting moulded poroplastic support is first enjoined.

Illustrative Case of Manipulation of the Back.—

Miss W., aged 21. Four years previously the patient was walking along a pole in the gymnasium, when she slipped and fell astride. She immediately experienced severe pain in the perineum and coccygeal region, but there was never any evidence of any gross lesion of the pelvis, spine, or of the pelvic viscera, either clinically or radiographically. A very

severe form of traumatic neurasthenia followed, associated with chronic invalidism. The principal complaints were lack of energy, so that it was impossible to play games, although previously the patient had been most active and keen. There was complaint of almost constant pain in the lower part of the spine, and that the back frequently "gave way." She had consulted many distinguished surgeons, both in this country and on the Continent. Her back and pelvis had also been manipulated nearly fifty times by an osteopath.

On examination, vague tenderness was found over the lower part of the spine and over the pelvis generally. The back moved well, and there was no evidence clinically or radiographically of any gross displacement. The mentality was introspective and apprehensive. A diagnosis of hysterical spine was made. The following plan of campaign was formulated: The patient was assured that no serious organic disease or lesion was present, but that some condition was present which could be completely put right by manipulation followed by a course of exercises. Manipulation of the spine was accordingly performed under gas and oxygen anæsthesia, and the principles of after-treatment, to which we have already referred, religiously carried out.

Seven weeks later she wrote: "I am riding, swimming, and playing tennis every day, and it is simply marvellous, and we didn't believe it could ever be. It will just make all the difference to the rest of my life and to other people's too." The cure has been maintained.

CHAPTER VIII

MISCELLANEOUS

IN addition, however, to the value of manipulation in certain carefully selected cases of disabilities of the articulations, we have now to consider its uses in a large group of conditions affecting the muscular system and tendons, fasciæ, aponeuroses, and ligaments. Very often cases occur in which muscular fibres are torn either by a sudden forcible contraction, by overstretching, or by a direct blow. In other cases the connective tissue in or around the muscle becomes involved in the injury, or the well-defined fasciæ and aponeuroses that separate or cover groups of muscles may be involved simultaneously, or even separately. Ligaments may be torn either partially or completely, and this is particularly liable to occur in the case of the spine, where the ligaments are of great number and complexity. In all cases, the pathological sequence is the same—viz., the formation of adhesions or scar tissue, which may be in the substance of a muscle or in its sheath, or in fascial, bursal, or ligamentous structures in the vicinity.

An area of scar tissue in a muscle or its sheath results in pain when the affected portion of the muscle actively contracts, and there is also pain when the muscle is passively stretched. If, for instance, an area of scar tissue is present in the upper fibres of the trapezius, there will usually be pain on actively elevating the shoulder or on active lateral flexion of the neck towards the same side, and also on lateral flexion of the cervical spine towards the opposite side. In many of these cases, a localised area of somewhat elastic consistency can be felt in the muscle, which is distinctly tender to pressure. In the author's opinion, the lump is not entirely due to scar tissue, but to localised muscle spasm caused by the irritation due to the presence of the scar tissue. The stretch-

ing of scar tissue is painful, and an involuntary and quite localised spasm occurs in its vicinity to prevent stretching thereof. But this muscular spasm is also painful, and in severe cases, may spread to the whole of the affected muscle. The very means that the body adopts to prevent stretching of the scar tissue in all probability cause more pain than would the stretching of these self-same adhesions. When scar tissue involves connective-tissue layers between groups of muscles there must obviously be interference with the mutual movement between opposed muscles. An excellent example of this is seen in injuries to the fasciæ in the calf, which separate the different groups of muscles.

Inflammation of a bursa separating a muscle or its tendon from some bony point may be followed by adhesions between the walls of the bursa, or even between the tendon or muscle and the subjacent bone. In either case, pain and sometimes slight limitation of movement, will occur when the muscle is put into action or passively stretched. This limitation must be distinguished from that due to fluid in the bursa or to the presence of active inflammatory changes therein. This is not always an easy matter, but when in doubt and faced with an obstinate case, manipulation may well be given a trial.

Treatment.—The affected portion of muscle is subjected to firm but systematic kneading. It is remarkable to observe how, as the kneading proceeds, the swelling, where previously present, gradually disappears owing to the inhibition of the localised muscle spasm. The mere disappearance of the swelling is no proof, however, that the scar tissue responsible for its existence has been effectually dealt with. Even firmer deep manipulation must now be performed to deal with this scar tissue, and this becomes easier owing to the disappearance of the localised spasm. In some cases it is found that after the manipulation the tender nodule has considerably diminished in size, but that a certain amount of swelling is still present. In such cases, a second or third manipulation may be necessary before the swelling finally disappears. An anæsthetic, either general or local, is usually desirable, but is not absolutely necessary, especially in the slighter type of case.

Where the evidence points to the presence of scar tissue in the connective-tissue membrane or aponeurosis between certain muscles or groups of muscles, as, for example, in the calf, the surgeon takes a firm grasp of the fleshy bellies of the superficial calf muscles with one hand and grasps the deeper muscles with the other hand. Then by firm purposeful movements the superficial group of muscles is made to slide from side to side and from before backwards upon the deeper group. In the limbs such digital manipulation of muscles and of one muscle or muscle group upon another is perfectly feasible, but in the case of the spinal muscles, the procedure is more difficult, and we have to rely mainly upon manipulation of the spine itself to break down adhesions in its muscle groups. For details of the technique of such manipulation, see Chapter VII.

Scar tissue in a muscle, tendon or fascial plane can also be effectively dealt with as follows: The muscle is put upon the stretch by an appropriate movement of an adjacent joint or joints, which movement must be carried out firmly. For instance, in the case of scar tissue in the calf muscles or in the fasciæ separating the different layers thereof, the knee is fully extended to lengthen the gastrocnemius and plantaris, and the foot is then dorsiflexed at the ankle-joint as fully as possible.

Illustrative Case—Scar Tissue in Calf Muscles.—

Colonel G., an athletic and healthy man of 38, stated that during a mountaineering and fishing holiday in Wales he overstrained himself in climbing a steep hill, and felt a sudden pain in the back of the right calf. Shortly after, he noticed painful cramp in the calf after walking a short distance. After deer-stalking and salmon-fishing in Scotland, the pain in the right calf continued. On his return to London, he remained free from pain for several weeks, until a game of hockey caused a severe recurrence of pain in the right calf.

A diagnosis of neuritis was made by a physician, and X rays of his teeth were taken, which led to extraction of an infected tooth. X rays of the affected leg showed nothing abnormal. Then his tooth-powder was analysed, and found to contain a trace of arsenic. A surgeon considered the condi-

tion to be "functional." A course of ionisation was tried for some time, with but temporary benefit. An eminent neurologist next diagnosed the condition as one of intermittent claudication, and ordered a course of hot-wax baths for the legs.

On examination it was found that the limb was well developed, but that a slight degree of wasting in the calf was present. There was deep tenderness in the middle third of the calf. All movements were free and painless, with the exception of full inversion of the foot, which caused pain in the calf. The circulation of the limb appeared good at the time of examination, and sensation was normal.

Manipulation was performed. The foot was first forcibly dorsiflexed and inverted with the knee fully extended, and secondly the calf muscles in the affected zone were subjected to firm kneading, the superficial muscles being rolled upon those deeper. After-treatment in the form of radiant heat, massage, and exercises was carefully followed. He made a most satisfactory recovery.

Manipulation in "Tennis Elbow."

Twenty years ago, when the underhand forehand drive was more in vogue than at the present day, the most characteristic form of "tennis elbow" was one in which pain and tenderness were present just above the internal condyle of the humerus, and in some cases at the insertion of the pronator radii teres.

In modern times, the pain and tenderness are most often encountered upon the outer side of the joint, although the former is often referred down the back of the forearm. The tenderness is usually very localised, and in typical cases may be present (*a*) over the tip or posterior aspect of the external epicondyle of the humerus, (*b*) over the superior radio-ulnar joint, (*c*) over the lower part of the external supra-condylar ridge. Occasionally tenderness is present at some more atypical spot or at more than one of these sites. It is probable that these represent different types of "tennis elbow." Before discussing these pathological types, it is necessary briefly to refer to the ætiology.

In gripping the handle of a tennis racket firmly, although the flexors on the anterior aspect of the forearm play a principal

part, the extensors also can be felt to be in a state of tension. In making a drive, at the moment of impact, the tension of the extensor group may be suddenly increased and a sprain may occur at the common origin from the external epicondyle. It is probable that this method of causation is commoner than the back-hand stroke. The grip factor is of great importance.

A writer in the *Journal of the Naval Medical Service* recently pointed out that he was treating three cases of "tennis elbow" in men who had never played tennis, but who were hammermen in Sheerness Dockyard. In these cases also, the symptoms were probably caused by the sudden increase in the tension of the extensor muscles at their origin caused by each blow of the hammer.

A doctor who is a keen tennis player and has made a special study of "tennis elbow," from which he was himself a sufferer, wrote: "Three years ago I had a bad 'tennis elbow' which I attributed to trying to do the reverse American service, the movement necessary for which being the opposite to the backhand stroke. When my elbow was bad, I found the backhand stroke actually more comfortable than the forehand."

Sufferers from "tennis elbow" frequently find the gripping of objects painful, and the normal co-ordination between the flexors and extensors is so far disturbed that in many cases there is sudden loss of power in attempting to lift quite light objects.

On routine examination of a case of "tennis elbow," it will often be found that if after flexing the fingers and wrist the elbow be then fully flexed, pain will be experienced over the site of origin of the common extensor group, and in some cases, full flexion is slightly restricted.

In another type of case, extremes of rotation at the superior radio-ulnar joint give rise to pain or are slightly restricted. In a third type no pain on movement can be elicited, but well marked tenderness is present over the external epicondyle or slightly above the point.

In the first type it seems clear that the condition is one either of scar tissue in the tendinous common extensor origin, or of adhesions between the tendon and the underlying epicondyle.

In some cases, according to Osgood, an adventitious bursa is present in this situation.

In the second type it seems clear that the condition is one either of adhesions in the superior radio-ulnar or outer part of the elbow-joint, or of nipped synovial fringe; and in the third type it is probable that the condition is more of the nature of a periostitis without adhesions (epicondylitis).

Even the most obstinate adherent to the doctrine of rest and splintage would admit that brilliant and rapid cures of "tennis elbow" may, in some cases, be effected by manipulation. It therefore behoves us to inquire in which of the above-mentioned types manipulation is indicated, and in which types it is contra-indicated.

In the author's opinion, the types which are associated with pain on some particular movement, together with slight limitation of this movement, respond best to manipulative measures. In those cases where periostitis without adhesions appears to be the most prominent factor, it is difficult to see how manipulation can be of any avail, and in these cases abstention from actual playing for a while with daily massage, electrical treatment and gentle exercise is the best treatment. The latter treatment should, needless to say, always be given a trial for a few weeks even when adhesions are present, as in many minor cases it effects a cure. Manipulation should be reserved for the more obstinate types.

A few words concerning the treatment by complete rest. Although minor cases of periostitis may respond to this method, it is probable that recovery would be more rapid with *properly administered* massage and other local treatment as mentioned above. In developed cases of adhesions, treatment by complete rest is associated with disappearance of symptoms during the period of rest, but as soon as the patient commences to play again the symptoms recur. This process is often repeated over and over again, because a certain school of thought seem unable to realise, firstly, that rest in the presence of inflammation is a potent cause of adhesions and, secondly, that rest cannot bring about a dissolution of adhesions.

CASE.—Miss S., masseuse. Complained of all the typical symptoms of "tennis elbow." Localised tenderness was present over the middle of the external lateral ligament of the elbow-joint associated with pain on flexion of the wrist with the fingers simultaneously flexed into the palm. The condition very seriously interfered with her work as masseuse. The onset and course of the condition are described in the following personal account by the patient: "During the strike I drove a car with very heavy gears and no self starter, and must have overstrained my arm without realising it. Shortly after, I played in a tennis match, and could hardly carry on, as there was a sickening pain in the elbow, and back-handers were almost an impossibility. The pain seemed to be between the bones of the outer side of the elbow-joint, as if a red-hot poker was pushed between. A definite spot on the bone hurt on pressure, as did also the upper part of the outer side of the forearm. When movement took place, there were sharp stabs of pain in the elbow-joint which shot down the outer side of the forearm. I was unable to grip anything, to lift a cup, or even to shake hands without considerable pain. For the first few days the fingers were swollen. The elbow was treated with ionisation, radiant heat, massage, and complete rest for four weeks. Then finger exercises, etc., were started, and at the end of five weeks the elbow was as bad as ever. I was unable to grasp a racquet without the *same* degree of pain as I had before the five weeks complete rest and treatment. After the manipulation, the result was immediate. I shook hands without pain, and was able to drive the car home (five miles) immediately afterwards without a twinge. I have played tennis every week-end, and have had no pain in the elbow whatsoever. Backhanders and even hard backhand volleys do not hurt it now." Three weeks later the patient played in a tournament lasting six hours without discomfort, and the cure has been maintained.

Manipulative Technique.—Under gas or gas and oxygen anæsthesia, the elbow is first fully flexed and then fully extended. The elbow is then fully flexed again, and while exercising firm thumb pressure upon the outer side of the joint, rapid rotatory movements are performed as the manipulator slowly passes from full flexion to full extension. The same movement is again repeated, but with the fingers fully flexed into the palm and the hand flexed at the wrist joint. Finally, firm kneading of the extensor muscles of the forearm is performed.

Slipped Tendon.

This is a comparatively rare accident, but one which must always be borne in mind, particularly in injuries in the vicinity of the ankle-joint. One of the peronei tendons may slip forwards on to the outer surface of the external malleolus owing to rupture of the external annular ligament. It should be immediately treated by plantar flexion and eversion of the foot combined with digital reposition. The tendon must be retained in its proper position by firm pressure. Massage may be instituted immediately, but all movements which tend to stretch the damaged annular ligament, must be avoided until repair has taken place therein, as otherwise the condition is apt to become recurrent.

Unless, however, this type of case is seen quite early, operation is required, for in chronic cases, fixation with a pad is usually ineffectual.

The Sacro-Iliac Joint.

Surgical Anatomy.—A marked discrepancy exists in the descriptions of this important joint as given in the standard text-books of anatomy. It is a somewhat difficult joint to dissect or demonstrate satisfactorily, with the result that it is often neglected. Unless, however, we stand upon a solid rock of anatomical and physiological knowledge, how can we analyse or criticise the vast literature that is growing up around this region or confound the charlatan?

Lengthy controversies have taken place as to whether a subluxation can or cannot take place at this joint, and it has often seemed to impartial observers that the participants have in many cases had a somewhat vague idea of that crucial fact, the anatomy of the joint. An eminent orthopædic surgeon, now deceased, who held that sacro-iliac strain or subluxation did not occur, referred to that joint as a synchondrosis. Cunningham's "Anatomy" refers to the sacro-iliac joint as a diarthrosis formed between the contiguous auricular surfaces of the sacrum and ilium, and states that each of the

surfaces is more or less completely clothed by hyaline articular cartilage. Reference is made to the capillary nature of the joint interval which may be crossed by fibrous bands, and to the imperfect and rudimentary nature of the articular cavity.

Morris speaks of the joint as a diarthrosis (subdivision, arthrodia), but refers to an ear-shaped cartilaginous plate which unites the bones firmly and is accurately applied to the auricular surfaces of the sacrum and ilium. It is about 2 millimetres thick in the centre, but becomes thinner towards the edges. Though closely adherent to the bones, it tears away from one entirely, or from both partially, on the application of violence. It is really one mass, and is only occasionally formed of two plates with a synovial cavity between them. A more or less extensive synovial cavity is occasionally present within the fibro-cartilage, and also a synovial lining to the ligaments passing in front and behind the articulation.

Gray's "Anatomy" classifies the joint among the amphiarthroses, but otherwise the description given closely corresponds with that given by Morris.

Testut sums up the matter by stating that the articulation resembles an amphiarthrosis by the limited amount of movement possible, and by the presence of a layer of fibro-cartilage between the articulating surfaces, but that it resembles a diarthrosis in having a joint cavity and a synovial membrane. He adopts Sappey's classification of the joint as a diarthro-amphiarthrosis.

Sappey has minutely described the cartilaginous coverings of the articular surfaces. He states that they have not the pure white and glistening surface of articular cartilage; that the sacral surface is smooth, but that the iliac is rough and tuberculated, and that while the cartilage of the iliac surface is fibro-cartilage, that which clothes the sacrum consists of two layers—a deep of hyaline cartilage, and a more superficial of fibro-cartilage.

Brooke has recently re-examined the anatomical problem, his observations being based upon examination of two hundred sacro-iliac joints, obtained from dissecting room and post-mortem subjects.

His conclusions are that the old description that the joint was an amphiarthrosis was the description of a pathological change. The normal joint is of the diarthrodial type, and in all probability takes part in movements backwards and forwards of the lumbar spine. Male and female joints are quite distinct in function and mobility, for whereas the former is built for strength, aided by the presence of extra and intra-articular tubercles, the latter is altered to meet the requirements of parturition and an increase in mobility. This it does by movements in a transverse direction as well as the rotatory movement described by Walcheren. The joint cavity itself is well defined, with a continuous fringe of synovial membrane attached to the margins of the articular cartilage.

The author's personal observations are in accordance with these views.

Ligaments.—The articular areas of the sacrum and ilium are connected by the following ligaments:

- Anterior sacro-iliac.
- Short posterior sacro-iliac.
- Long posterior sacro-iliac.
- Interosseous sacro-iliac.

The anterior sacro-iliac ligament is of moderate density and is attached to the anterior and inferior or pelvic margins of the articular surfaces. The short and long posterior sacro-iliac ligaments need no special notice, but the interosseous ligament is of great importance. It is called by some anatomists "the deep portion of the posterior sacro-iliac ligament," and the ligament, which is enormously strong, passes between the rough areas above and behind the auricular surfaces of ilium and sacrum. Its function is an important one. It is to be remembered that the sacrum differs from the key-stone of an arch in that its ventral surface is wider than the dorsal. There is thus a tendency in the erect position for the superimposed bodyweight to drive the sacrum downwards and forwards into the pelvis. This tendency is counteracted by the exceedingly strong interosseous ligament.

Articular Surfaces.—The articular surfaces of sacrum and

ilium are somewhat L-shaped, the anterior limb being somewhat shorter and wider than the inferior limb. The articular surface of the sacrum is slightly concave from side to side, the concavity being most marked at the angle between the two limbs. Here the junction between the posterior and upper borders forms a prominent lip which fits into a corresponding depression behind the convex articular surface of the ilium. This constitutes an important interlocking mechanism around which rotation takes place. If, moreover, a coronal section be made through this portion of the pelvis, it will be seen that this part of the sacrum constitutes a wedge, the truncated apex of which is directed downwards.

Movements.—A slight but quite definite amount of movement, both gliding and rotatory, occurs at this joint. Gliding may be upwards and downwards, or forwards and backwards, and movement in the latter plane is associated with a rotatory movement around the interlocking mechanism of the middle segment described above. During this rotatory movement, assuming that the force is acting from above, the anterior and upper part of the sacrum is tilted downwards and forwards, thus diminishing the antero-posterior diameter of the pelvic inlet, and the lower and posterior part is displaced upwards and backwards, increasing the antero-posterior diameter of the pelvic outlet.

Forward pressure upon the lower end of the sacrum will have the opposite effect. The movement of the upper segment is principally limited by the strong interosseous and posterior sacro-iliac ligaments; that of the lower segment by the great and small sacro-sciatic ligaments.

Affections of the Sacro-Iliac Joint.

The joint is subject to many of the injuries and diseases which are encountered in other articulations. Owing, however, to its deep-seated position, the indirect nature of many of the signs and symptoms, and its intermediate position between the hip-joint and spine, diagnosis sometimes presents special difficulties. We are here concerned, however, solely with those conditions of the sacro-iliac joint which can be

benefited or cured by manipulation, and shall, therefore, confine our remarks to the conditions known as sacro-iliac strain and subluxation.

Mechanism of Lumbo-Sacral and Sacro-Iliac Strain and Subluxation.

Bilateral Cases.—We have already noted that excessive downward and forward rotation of the sacrum is normally prevented by the strong interosseous posterior sacro-iliac ligaments. When for any reason such rotation has become extreme or excessive it is clear—particularly in bilateral cases—that great strain is also exercised at the lumbo-sacral articulation, particularly at the articulations between the articular processes of the fifth lumbar vertebra and the first sacral vertebra. In this way the articular surfaces are forced into firm and close apposition, leading to pain and limitation of movement. Posture, instead of being maintained by muscle tone, becomes largely dependent upon ligaments which become unduly stretched, and upon excessive strain upon articular surfaces. In an attempt to restore the normal equilibrium, compensatory lordosis of the lumbar spine takes place, and profound alterations and disturbances accrue in the spinal mechanism. The rotation of the sacrum is the primary factor in a train of consequences, giving rise to a complicated syndrome, in which, owing to muscular wasting, a vicious circle can often be traced.

In other cases, particularly after prolonged dorsal decubitus, the opposite state of affairs exists, and the upper end of the sacrum rotates backwards and the lower end forwards. In these cases the normal forward convexity of the lumbar spine is diminished, leading to pronounced flattening of this region. This type which Goldthwait considered to be that most frequently encountered, also leads to serious alterations in the spinal mechanism.

Unilateral Cases.—Strain is usually brought about by force applied to the ilium, often owing to a sudden and violent contraction of the hamstrings, the displacement at the sacro-iliac joint when present being usually a slight displace-

ment of the ilium upon the sacrum. Pregnancy and prolonged illness are important predisposing causes of sacro-iliac strain or subluxation. In the former, relaxation of the joint ligaments is physiological, and in some cases the normal stability is never completely regained. After prolonged illness, the muscular tone may be seriously diminished, and the normal support of the spine withheld, so that undue strain is placed upon ligaments, relaxation occurs, and the spinal mechanics profoundly altered. If a sudden and violent contraction of the hamstrings on one or other side occurs, a rotatory force is applied to the innominate bone which moves upon the sacrum, and acute sacro-iliac strain or subluxation thereby produced.

Subluxation.—It is probable that the irregularity of the articular surfaces of the sacro-iliac joint predisposes to subluxation. It is easy to see that a unilateral rotatory displacement of the innominate bone upon the sacrum of a fraction of a millimetre might cause acute pain and disability and might become fixed owing to the irregularity of the articular surfaces.

To sum up, chronic strain may give rise to relaxation of the joint ligaments, which may or may not be associated with subluxation. Acute strain may occur alone, may be associated with subluxation, or may be followed by symptoms of chronic strain as above.

Pain.—The nerve supply of the sacro-iliac joint is derived anteriorly from the lumbo-sacral cord (L. 4 and L. 5), posteriorly from the first and second sacral nerves, and below from the superior gluteal nerve. The obturator nerve may, in some cases, contribute to the innervation of the joint. Owing to these innervations, pain may be referred to the posterior aspect of the thigh or to almost any part of the leg. Usually, however, the leg pain is felt on the antero-lateral and posterior aspect thereof, and on the outer aspect of the ankle. Pain may also be felt which follows the course of the superior gluteal nerve from the sacro-sciatic notch outwards towards the tensor fasciæ femoris. When the obturator nerve takes part in the innervation of the joint, pain may also be experienced upon the inner aspect of the thigh.

Effect of Position upon Pain.

Standing.—The patient usually bears most weight upon the leg of the unaffected side, and keeps the leg on the affected side slightly flexed, as this relaxes the hamstrings and lessens weight transmission through the affected joint.

Sitting.—The patient sits upon the unaffected buttock, thus avoiding weight transmission and pressure upon the sciatic nerve on the affected side.

Lying.—The patient usually lies either upon the back or upon the unaffected side.

Walking.—This usually aggravates the pain, and in going upstairs, the patient usually progresses one stair at a time, dragging the limb of the affected side after him. The patient tends to walk with the body inclined away from the affected side.

Tenderness is usually present.

(1) Over the posterior sacro-iliac ligament between the posterior superior, and posterior inferior iliac spines.

(2) At the sacro-sciatic notch over the position of the superior gluteal nerve.

(3) Over the sciatic nerve as it lies midway between the ischial tuberosity and the great trochanter at the level of the gluteal fold.

Movements.

Flexion of Spine.—The movements that are restricted or painful in the standing, sitting, and lying positions respectively may be tabulated as follows, in which table comparison is also made with the corresponding movements in lumbo-sacral conditions:

Lumbo-Sacral Conditions.

STANDING.	SITTING.	LYING.
Muscle spasm keeps lumbo-sacral region rigid and forward bending takes place at hips and in upper lumbar and dorsal regions.	Same limitation occurs as in flexion standing.	Passive lumbar flexion by flexing hips on pelvis painful and restricted as on flexion, standing and lying.

Sacro-Iliac Conditions.

STANDING.	SITTING.	LYING.
The patient bends forward first by flexing lumbar spine, usually remarkably then by tilting pelvis until free as owing to re-absence of leverage. hamstrings become taut. laxation of hamstrings Motion usually free Next he either stops or bends no leverage is trans- and painless except further by flexing knee and mitted to the pelvis. in very acute cases. relaxing hamstrings.	Forward flexion	Pelvis moves as a whole owing to absence of leverage. Motion usually free and painless except in very acute cases.

Straight Leg Raising.—If the lower extremity be raised from the couch to the vertical with the knee fully extended, the hamstring muscles become taut, and unilateral tension is brought to bear upon the pelvis. In sacro-iliac cases this test is painful, but this test is productive of pain in certain other conditions such as sciatica.

Owing to the patient inclining the trunk away from the affected side, a functional scoliotic curve of the lumbar region develops with its convexity towards the affected side. Compensatory tilting of the pelvis occurs with apparent shortening of the lower extremity on the side of the lesion. Wasting of the muscles of buttock and thigh is frequently present. There is on occasion, pain on compressing the iliac bones together, and difference in the relative positions of the posterior superior iliac spines. A functional element is frequently present in these cases.

According to Goldthwait, although in lesions of the sacro-iliac joints there is almost invariably limitation of some of the motions, in certain cases there is also an increase in the normal motion, particularly when, as the result of long-continued strain, the joints are much relaxed.

This may be detected by hyperextension of the thighs, or if the crests of the ilia are grasped with two hands, the thumbs resting on the sacrum and the patient raises first one knee and then the other, the motion of the sacro-iliac joint may be felt. In these cases the patient often complains of a feeling of marked instability.

In the present state of our knowledge, although we are often able to state quite definitely that the sacro-iliac joint is at fault, it is often extremely difficult to state the exact nature

of the lesion. Sacro-iliac strain, both acute and chronic, and conditions of relaxation are recognised clinical entities. The author, although he believes that acute unilateral subluxation is anatomically possible, and is often led to suspect it strongly in many cases, does not, after carefully weighing the available evidence, consider that the diagnosis can at present be made with any degree of certainty.

Radiographic Appearances.

We here approach a problem concerning which there is considerable difference of opinion. Some deny altogether the possibility of subluxation. Others, although admitting the existence of sacro-iliac strain and subluxation as clinical entities, deny that the latter condition is recognisable radiographically. Those holding the opposite view point out that the displacement is not vertical but rotatory, and that a stereoscopic radiogram of the whole pelvis is necessary for its demonstration, and also to demonstrate disalignment of the symphysis which is said to be diagnostic. It must be remembered that minor abnormalities of the pelvis are frequently discovered accidentally and give rise to no symptoms; moreover, a slight difference in the projection of the X rays on the two sides may give rise to an appearance simulating a displacement. It appears therefore that a diagnosis of sacro-iliac subluxation cannot be made from the X ray alone, but that in certain cases, a good stereoscopic X ray of the whole pelvis may furnish useful confirmatory evidence.

In chronic cases of relaxation, proliferative changes may be seen at the joint margins, particularly below, or increased density along the joint line.

Treatment.—In cases of chronic strain the condition primarily is due to weakened musculature, and our aim must be to correct this by a judicious combination of support and muscular re-education. All faulty attitudes, both standing and sitting, must be corrected, and radiant heat and massage are helpful in many cases.

It must never be forgotten that although mechanical supports are useful as a temporary measure, they do not

correct the primary muscular weakness, and a successful issue depends largely upon performance by the patient of the essential exercises.

In those cases in which these measures have been given a fair trial but unsuccessfully, and in those cases in which subluxation is suspected, both from the X ray and the obstinate nature of the symptoms, manipulation often proves a most successful procedure. The same plan of campaign may be first of all adopted even in those cases associated with abnormal laxity of the joint.

Manipulation, however, often fails in this type of case, and if a judicious combination of mechanical support by a corset or special belt and of muscular re-education fails to relieve the pain and disability, it will probably be necessary to produce ankylosis of the joint by means of a bone graft.

Many acute forms of strain, or rather sprain, recover with such local measures as rest, radiant heat, and massage. Other cases prove extremely resistant to every form of local treatment, and it is highly probable that in these cases we are faced with a subluxation, particularly if the X ray shows alteration of alignment, or it is possible that the persistence of symptoms in some of these cases may be due to adhesions.

In these cases the percentage of cures by manipulation is high.

Manipulative Technique.—There are many different methods of manipulating this joint with or without anæsthesia.

Perhaps the most reliable methods are as follows:

If the displacement of the sacrum appears to be backwards, the thigh is flexed as fully as possible with the knee fully extended. This has the effect of rendering the hamstrings tight, and owing to the attachment to the ischium, this portion of the innominate bone is pulled forward, resulting in the iliac bone slipping backwards into position upon the sacrum. In bilateral cases the process must be performed upon both sides.

If, on the other hand, the displacement of the sacrum appears to be forwards, the patient is placed in the prone position or lying upon the side, and the thigh is hyperextended. During this movement the innominate bone moves with the femur,

owing to the attachment of the Y-shaped ligament of Bigelow, and the ilium slips forward into place.

After-Treatment.—In the more acute cases relief is usually immediate, as once the displacement has been reduced, there appears to be no tendency to recurrence. No special after-treatment or retentive apparatus is necessary. In the chronic cases associated with relaxation and weakened musculature, temporary support in the form of a sacro-iliac belt should be combined with muscular re-education which is essential to militate against a recurrence of symptoms.

Manipulation in Sciatica.

It appears clear that in most cases of so-called idiopathic sciatica of long standing, scar tissue is present in the sheath of the sciatic nerve.

In some cases manipulative stretching of the sciatic nerve is of benefit, although the benefit is sometimes only temporary. Yet where everything has been tried in vain, such treatment is certainly worthy of a trial, and may be repeated if necessary.

It is seldom indicated in acute or recent cases, and preliminary elimination by medical measures of any contributory toxic or infective focus is indispensable.

Technique.—The patient lies upon the back on a low couch, and must be somewhat deeply anæsthetised, nitrous oxide being usually insufficient.

The pelvis is fixed, and the manipulator, after first kneading the sciatic area, firmly flexes the thigh while the knee is fully extended.

In some cases, the results are most satisfactory. It is obvious that every case of sciatic pain requires the closest and most thorough investigation, and the diagnosis of idiopathic sciatica should never be made until the possibility of the pain being referred from spine or sacro-iliac joint or from disease of the pelvic viscera has been ruled out of court. In others, however, there is either no improvement or this is of a temporary nature. The author has not personally encountered a case where the symptoms were increased by manipulation.

CHAPTER IX

DANGERS OF MISAPPLIED MANIPULATION

THE potential dangers of osteopathic or chiropractic manipulations have already been commented upon, and it has been shown that not only may there be danger in the manipulations themselves, but that even when more futile than dangerous, this form of treatment may prevent a patient from seeking proper medical advice until, as in cases of malignant disease, the favourable moment has irretrievably passed. In this chapter, however, we are principally concerned with the dangers of manipulative treatment apart from osteopathy.

Tuberculous Arthritis.—This subject has been discussed under the section Differential Diagnosis in Chapter III. The subject, however, is of such paramount importance, and the dangers of manipulation in these cases so great, that at the expense of a certain amount of recapitulation, it is considered advisable to emphasise again a few special points.

One of the most important groups of cases in which manipulation has often been fraught with disaster consists in tuberculous disease of a joint. In many of these cases, the symptoms are acute, the pain is severe, and it must be obvious even to the most ignorant that manipulation of any kind is absolutely contra-indicated. It is well known, however, to all experienced practitioners, that there are many cases where tuberculous disease of a joint is of a very chronic nature, with slight swelling of a joint, particularly after exercise, a little limitation of movement in certain directions, and localised tenderness. At first sight such a case may appear to be one of chronic synovitis due to some mechanical cause, and it is often only by the most thorough and exhaustive examination by a trained and qualified practitioner that an accurate diagnosis is arrived

at. There have been many disastrous results of manipulation by bone-setters in such cases. Differential diagnosis has already been touched upon (*vide* Chapter III.), but there are two signs in particular that should make the practitioner suspicious. These are (*a*) persistently raised temperature over the joint, (*b*) marked muscular wasting. There is, again, a large and important group of stiff joints due to old tuberculous disease in which signs of active disease are no longer present. In these the clinical sign of raised local temperature will not be present, and principal reliance must be placed upon the history and the radiographic appearances taken in conjunction with the other clinical signs previously mentioned. The surgeon must never allow himself to yield to pressure on the part of patient or relatives to perform manipulation with the object of restoring movement to such a joint. What are the dangers of manipulation in this type of case? The tubercle bacilli which have become imprisoned by connective tissue may be set free by the forced movement, and give rise to an acute inflammatory condition of the joint, which may progress rapidly. Abscesses may form, burst, and give rise to chronic discharging sinuses, which, again, are liable to become secondarily infected. Amputation may become necessary owing to complete disorganisation of the joint and to prevent the patient steadily going downhill from pain, secondary infection, or lardaceous disease.

Worse still may happen, for the forced movement may not only stir up the latent organisms in the joint into activity, but, in children particularly, may disperse them throughout the body by the circulation, giving rise to generalised miliary tuberculosis, and death may ensue.

In these cases deformity can, however, sometimes be rectified by open surgical operation.

Fracture of an Adjacent Bone or Damage to Blood-vessels, Nerves, or Other Important Structures.

It must always be remembered that in cases of ankylosis of a joint, the bones in the region of the articular ends undergo a greater or lesser degree of disuse atrophy. In attempting to restore movement in such cases there is a grave risk, unless great care be taken, of causing a fracture of the adjacent bone. The same risk is present in cases of unreduced dislocations of long standing in which peri-articular contracture has occurred, and in such cases a degree of force, which is insufficient to remove the obstruction to movement caused by such peri-articular contracture, may suffice to cause fracture of the bone. The golden rule to remember is that the cases in which there is risk of fracture owing to the density of adhesions, are the very ones in which manipulation is of doubtful efficacy, and attended with the least satisfactory results. Here, again, we may learn a lesson from the most successful of the bone-setters, for they almost invariably leave this type of case severely alone, and although great emphasis is laid upon the risk of fracture during manipulative work, it is important to bear in mind that the type of case in which serious risk of its occurrence exists is best treated by open operation, or by manipulation combined with such, wherever feasible. Neither is it fair to judge the value of manipulation by the somewhat disappointing results seen in this type of case.

The reaction when such dense adhesions are broken down is so severe, that the tendency to restiffening of the joint is very great. The choice in these marked cases, as we shall see later, lies between—

- (a) A series of manipulations, the manipulator resting content with a few degrees of increased range by each, and consolidating the ground gained before launching a further attack.
- (b) Division of restricting bands and structures by open operation combined with manipulation.

These remarks apply also to the question of injury to blood-vessels and nerves during manipulation. As a general rule, such accidents can only be due to the use of an unjustifiable degree of force, or to the use of manipulation where open operation is in reality indicated.

Myeloma, Sarcoma, etc.

But there are other conditions in which manipulation is equally futile or dangerous. In the museum of the Royal College of Surgeons of England are at least two specimens of malignant neoplasm of the knee-joint obtained from limbs which, previous to amputation, had been subjected to manipulation by bone-setters.

In the museum of St. Bartholomew's Hospital is a specimen (No. 471b) of myeloid sarcoma of the head of the tibia, with the following description:

"Removed by amputation from a man aged 36 years. Four years previously he began to suffer pain in the left knee-joint, and was advised to wear an elastic knee-cap. This he did for six months. Towards the end of that period, the knee began to enlarge and grow slowly bigger. Twenty months before the operation, he consulted a bonesetter, who diagnosed displacement of a cartilage and conducted a course of fourteen manipulations without benefit to the patient."

Myositis Ossificans.

In this condition following an injury of, or in the vicinity of a joint, particularly the elbow-joint in children, there is a formation of new bone in muscle, ligament, tendon, or other connective-tissue structures. The condition is probably due to the liberation of osteoblasts or bone-forming cells from beneath the torn periosteum, which escape into the surrounding parts, where they proliferate. It is characteristic of this condition that massage, passive movements, and manipulation cause increased pain, swelling, and muscular spasm, and appear to increase the rate of formation of new bone. It is clear,

therefore, that they are contra-indicated. If a little painless active movement persists, it may be very carefully encouraged, and is a valuable sign of commencing recovery. It should steadily increase, provided misguided efforts at forced movement are avoided. There is no objection, however, if the joint has become fixed in a bad position, to manipulating it gently under anæsthesia into that position which experience has shown to be the best should ankylosis unfortunately occur. Manipulation or passive movements are also contra-indicated in most acute inflammations of joints, although gentle active movements, if at all possible, should be encouraged, and are valuable in preventing subsequent ankylosis.

CHAPTER X

NOTES ON AFTER-TREATMENT

THE principal points in the after-treatment have been as far as possible discussed under individual headings. In this chapter we shall endeavour to summarise briefly the principles thereof. For further details, special textbooks should be studied.

(a) In the first place, it may be stated that in all cases after manipulation, **the joint must be voluntarily moved through the increased range at the earliest possible moment.** In cases in which the adhesions were slight, the movements through the increased range must be performed immediately on recovery from the anæsthetic. It is often advisable to hold the limb in the previously impossible position, so that when the patient recovers from the effects of the gas he is personally convinced of his new power. In cases of moderate degree, the after-treatment is similar, but it may be two or three days before the patient can actively perform the full range of movement obtained by manipulation. In cases associated with the presence of more dense adhesions the limb is placed for a short period in the corrected position, which corresponds in most cases to the "position of election." For instance, the hip and shoulder are abducted and the wrist dorsiflexed. The joints are retained thus by appropriate splintage for a short time, which should rarely exceed twenty-four hours, in order to allow reaction to subside, massage being instituted from the first. At the end of this period, movements are instituted, active being more valuable than passive. It may, however, be advisable to refix the limb in the corrected position at the end of each period of movement for a variable period, which, however, should rarely exceed seven days.

(b) **Exercises and Muscular Re-education.**—In many cases, and in all in which adhesions are marked or have existed

for a long period, a certain amount of muscular wasting coexists, which may be general or affect some particular group. In some cases it is due to disuse, in others it is reflex, and not infrequently both causes are present in combination. To preserve the full range of movement obtained by manipulation, and thus prevent the renewed formation of adhesions, to restore the wasted muscles and the strength and usefulness of the limb, it is of first-rate importance to follow every manipulation by a well-planned course of muscular exercises. The principles of muscular re-education are beyond the scope of this work, but a few special points may be noted. As a general rule active exercises—*i.e.*, those performed by the patient—are far more efficacious than passive movements carried out for the patient by another person, or by a mechanical apparatus. Another principle to be followed in re-education of muscles is that over-exertion is to be carefully avoided, particularly at first, and that the exercises must be increased daily by gradual stages. At first the movements must be assisted, and later the movements are to be carried out against a gradually increasing resistance.

Electrical stimulation of the affected muscles, particularly by surging faradism, is valuable in obstinate cases.

(c) **Radiant Heat and Massage.**—These are a valuable preliminary to the above-mentioned measures in nearly all cases. Their soothing effect tends to abolish all muscular spasm; improved nutrition results from the increased vascularity produced, and it is probable that they have a softening effect on scar tissue. They are particularly efficacious in the more marked cases, especially those associated with chronic arthritis.

Finally, it can scarcely be sufficiently emphasised that save in very exceptional circumstances, the medical man who performs the manipulation should personally supervise the after-treatment. This rule entails that no medical man should perform a manipulation unless he has made a special study of massage, muscular re-education, and the principles of after-treatment, and is therefore in a position either to undertake the after-treatment himself or to give specific instructions to the masseur.

INDEX

A

- ABDUCTION of foot, 106
 - of hip-joint, 89
 - of shoulder-joint, 119, 121
 - of thumb, 148
 - of wrist-joint, 140, 142
- Accessory ligaments of hip-joint, 85
- Adduction of foot, 106
 - of hip-joint, 89
 - of shoulder-joint, 119, 120
- Adhesions, causes of, influence on
 - prognosis, 13
 - diagnosis of, 22
 - differential diagnosis in relation to treatment, 25
 - following sprain of internal lateral ligament of knee-joint, ætiology and symptoms, 45, 46
 - formation of, mode of, 16
 - prevention of, 19
 - hip-joint, manipulative technique in, 93
 - in arthritis, 12, 13, 33-37, 70-75
 - in contusions of knee-joint, 54
 - in metatarsalgia, 111
 - in synovitis, 12, 13
 - intra-articular, 12, 13
 - nocturnal aching due to, 24
 - of scapula, 124
 - of shoulder-joint, 124
 - of spine, prevention of, 163
 - organisation of, prevention of, by early movements, 19
 - outside joints, 21
 - peri-articular, 12
 - spinal, 161
- After-treatment, electrical stimulation of muscles in, 192
- exercises and muscular re-education in, 191
- massage in, 192
- notes on, 191
- of manipulation of hip-joint, 95
- principles of, 191
- radiant heat in, 192
- Anæsthesia, examination under, before operation, importance of, 23
- gas and oxygen, value of, in manipulation of hip-joint, 95
- in manipulative surgery, 31
- Ankle and foot joints, manipulation of, 107
- Ankle-joint, adhesions in, tenderness due to, sites of, 25
- and astragalo-calcaneal joint, coronal section of, 100
- ligaments of, 100, 101. *See also under Ligaments*
- manipulation of, dorsiflexion, 108
- illustrative cases of, 112
- movements of, normal, 103
- peri-articular tendons and synovial sheaths of, surgical anatomy of, 102
- surgical anatomy of, 99
- synovial membrane of, 101
- Ankylosis, false, 14
- fibrous, 14
- of shoulder-joint, 124
- osseous, 14
- true, 14
- Aponeuroses, injuries of, manipulation in, 168
- Arm, deformity of, after shoulder-joint lesions, prevention of, 124
- elevation of, 119, 122
- Arthritis, chronic, manipulation of, 70
- hip-joint in, 92
- movements in, value of, 73
- pathology of, 18
- involvement of articular cartilage in, 16
- liability to adhesions in, 12
- suppurative, treatment of, descriptive case, 4
- tuberculous, dangers of manipulation in, 186, 187
- Articular capsule of hip-joint, 84

B

- Back, musculature of, 157, 158
- Blood-vessels, damage to, due to manipulation, 188
- Bone-setters, cases cured by, adhesions in, pathology of, 12
- dislocations, 20
- functional, pathology of, 12, 19
- hysterical, pathology of, 19
- subluxations, 20
- Bone-setting, history of, 1
- Bones, fracture of, due to manipulation, 188
- Bucket-handle lesions of semi-lunar cartilage, 60, 61, 63
- Burns, joint contractures following, 15

C

- Capsule, articular, of finger-joints, 149, 150
- of inferior radio-ulnar joint, 141
- of wrist-joint, 138
- of knee-joint, 42
- Cartilage, articular, involvement of, in arthritis, 16
- in synovitis, 16
- Cato, bone-setting practised by, 1
- Cheselden, W., co-operation of, with bone-setters, 2
- Circumduction of shoulder-joint, 122
- of wrist-joint, 140
- Colles's fracture, 145-147
- Complement fixation test, 28
- Condyles, femoral, 43
- Contracture, dischæmic, 15
- Contractures due to burns, 15
- to loss of muscle substance or division of tendons, 15
- to paralysis, 15
- to prolonged functional immobility, 15
- suppuration, 15
- to sclerosing fibrositis, 15
- Contusions, adhesions in, 21
- of knee-joint, complications of, 53

D

- Dislocations, old, reduction of, danger of manipulative surgery in, 20

- Dislocations, reduction of, value of manipulative surgery in, 20
- unreduced, of long standing, dangers of manipulation in, 188
- work of Hippocrates on, 1
- Dorsiflexion of ankle, 104
- of wrist-joint, 144
- Drop-wrist, 144
- Dupuytren's contracture, 15

E

- Effleurage, 6
- Elbow-joint, adhesions in, tenderness due to, sites of, 25
- deformity of, prevention of, 134
- fixation of, by muscle spasm, 134
- ligaments of, 132, 133
- manipulation of, 134
- illustrative cases, 136, 137
- technique of, 135
- movements of, 133
- myositis ossificans and, 134, 135
- surgical anatomy of, 131
- synovial membrane of, 133
- X-ray examination of, importance of, 135
- Elevation of shoulder-joint, 119
- Eversion of foot, 105
- Exercises after manipulation, 191
- Extension and flexion of knee-joint, 44, 76
- of ankle, 105
- of hip-joint, 87
- of shoulder-joint, 118, 120
- of spine, 160
- of thumb, 148
- of wrist-joint, 139, 141
- Extra-articular causes of limitation of movement, 15

F

- Fasciæ, injuries of, manipulation in, 168
- Femur, intercondyloid notch of, 43
- Fibro-cartilage, triangular, of inferior radio-ulnar joint, 142
- Fibrositis, sclerosing, joint contractures due to, 15
- Fibrous ankylosis, 14
- Fingers, joints of, 149, 150
- manipulation of, technique, 151
- movements of, 150

Fingers, stiff, manipulation of, 150
 Flat-foot, adhesions in, tenderness due to, site of, 25
 causation of, 109
 treatment of, by manipulation, 110
 after-treatment in, 111
 Flexion and extension of knee-joint, 44, 76
 of ankle, 105
 of hip-joint, 87
 of shoulder-joint, 118, 120
 of spine, 160
 lateral, flexion element in, 160
 of thumb, 148
 of wrist-joint, 139
 with fingers extended, 139
 Flexors of toes, 103
 Foot, abduction of, 106
 adduction of, 106
 and ankle-joints, manipulation of, 107
 coronal section of, to demonstrate synovial cavities, 100
 eversion, of 105
 combined with abduction, 106
 inversion of, 105
 combined with adduction, 106
 painful, treatment of, by manipulation, 111
 pronation of, 106
 supination of, 106
 Forearm, "carrying angle of," 133
 pronation and supination of, 140
 Fracture-dislocation of internal semilunar cartilage, manipulation and treatment of, 80-83
 Functional conditions, manipulative treatment in, 32

G

Gastrocnemius, 43
 Grips for manipulation of hip-joint, 93

H

Hilton, J., teaching on orthopaedic surgery, 3
 Hip-joint, adhesions in, 93
 tenderness due to, sites of, 24

Hip-joint, diseased, positions assumed, 89-91
 manipulation of, 89
 after-treatment, 95
 illustrative cases, 97-99
 long leverage, 93, 96
 plaster and splints following, condemned, 95
 short leverage, 93, 94
 technique, 93
 range of movement of, 86-89
 sprains and contusions of, 91
 stiffness of, causes of, 91, 92
 surgical anatomy* of, 84
 synovial membrane of, 86
 Hippocrates, writings on bone-setting, 1
 Hood, Wharton, treatise on bone-setting, 8, 9
 Hunter, J., teaching on orthopaedic surgery, 2, 3
 Hyperextension of joints, 40, 44
 Hysterical conditions, manipulative treatment in, 32

I

Immobility, functional, prolonged joint contracture due to, 15
 Inflammation in relation to formation of adhesions, 16
 Infrapatellar pad of fat, 42, 43
 conditions of, amenable to manipulation, 65
 semilunar extensions of, 66
 Interphalangeal joints of thumb and fingers, 149, 150
 Intra-articular adhesions, 12, 13
 Inversion of foot, 105
 Ischæmic contracture, 15
 Ischio-capsular ligament of hip-joint, 85

J

Joints, adhesions in, differential diagnosis of, 26-28
 by X rays, 26
 outside, 21
 tenderness in, principal sites of, 24
 ankle and foot, manipulation of, 107
 technique, 108

Joints, ankylosis of, dangers of
 manipulation in, 188
 false, 14
 true, 14
 diseases of, diagnosis of, 22
 favouring development of
 adhesions, 12
 effusion in, hæmorrhagic,
 causing synovitis, 18
 functional condition of,
 manipulation in, 32
 hyperextension in, 40, 44
 hysterical conditions of,
 manipulation in, 32
 inflammatory conditions of,
 importance of movement
 in, 19
 limitation of movement of,
 due to extra-articular
 causes, 15
 value of manipu-
 lation in, 15
 movements of, importance of
 comparison with op-
 posite side, 40
 normal range of, 40
 pathology of, 12
 stiff, treatment by manipula-
 tion, neglect of, by medical
 profession, 6, 7
 tarsal, movements of, 104, 105
 tuberculosis of, dangers of
 manipulation in, 26-
 28, 186
 diagnosis of, 26
 quiescent, diagnosis of,
 28

K

Knee-joint. *See also* Semilunar
 cartilage
 adhesions in, prevention of
 formation of, 53
 tenderness due to, sites
 of, 24
 with destruction of ar-
 ticular cartilage, 17
 capsule of, 41-43
 contusion of, case reports,
 54, 55
 complications of, 53
 crucial ligaments of, 42
 flexion of, 44
 functional disorders of, mani-
 pulation in, illustrative
 case, 75

Knee-joint, internal lateral liga-
 ment of, ad-
 hesions fol-
 lowing sprain
 of, ætiology
 and symp-
 toms, 45-47
 injury of, case
 report, 51
 sprain of, de-
 fects in origi-
 nal treat-
 ment, 52
 ligamentum patellæ, 42
 manipulation of, after-treat-
 ment, 78
 indications for, 45
 technique, 76-78
 movements of, range of, 44
 rotation of, 44
 sprain of, chronic, with ad-
 hesions, treatment of,
 48, 49
 symptoms in neglected
 cases, 47
 surgical anatomy of, 41, 50,
 65
 synovial membrane of, 41-43

L

Lateral mobility in neglected cases
 of sprain, 48
 Leverage, long, in manipulative
 treatment of hip-joint, 93,
 96
 short, in manipulative treat-
 ment of hip-joint, 93, 94
 Ligament of ankle-joint, anterior,
 100
 capsular, 100
 deltoid, 101
 external annular, 102
 lateral, 101
 internal annular, 102
 lateral, 101
 elbow-joint, anterior, 132
 external lateral, 133
 internal lateral, 132
 posterior, 132
 wrist-joint, anterior, 138
 external lateral, 139
 internal lateral, 138
 posterior, 138
 Ligamenta alaria, 43
 Ligaments, crucial, 42
 injuries of, manipulation in,
 168
 of elbow-joint, 132, 133

- Ligaments of shoulder-joint, accessory, 115
- of spine, 159
- Ligamentum mucosum, 43
- patellæ, 42
- teres of hip-joint, 85
- Locking, mechanical, and limitation of movement, differential diagnosis of, 59
- in lesions of semilunar cartilage, 58, 59
- permanent, in lesions of semilunar cartilage, 60
- Lumbago, rheumatic, 162
- traumatic, 162
- and rheumatic, differential diagnosis of, 162
- Lumbar aponeurosis, injudicious treatment of, injuries due to, 159

M

- Manipulation combined with operative treatment, cases suitable for, 15
- contra-indications to, 186-190
- in functional disorders of knee-joint, 75
- in sciatica, 185
- in tennis elbow, 171
- in toxic or infective synovitis and chronic arthritis, 33, 70
- in treatment of affections of muscles, tendons, ligaments, etc., 168
- of stiff joints, neglect of, by medical profession, 6, 7
- misapplied, dangers of, 186
- of ankle and joints of foot, 107
- of elbow-joint, 134
- of great toe, 114
- of hip-joint, 89
- of sacro-iliac region, 184
- of shoulder-joint, 122
- of spine, 153
- indications for, 161
- of stiff fingers, 150
- of wrist-joint, 144
- Manipulative surgery, anæsthesia in, 31
- observations on, 1
- teaching of, in medical schools, need for, 10, 11
- treatment, contra-indications to, 26
- general principles of, 29
- Massage following manipulation, 192
- Menisci, repair in, sluggish, 58
- Metacarpo-phalangeal joints of thumb and fingers, 149
- Metatarsalgia, adhesions in, tenderness due to, site of, 25
- treatment of, by manipulation, 111
- Mid-tarsal joint, manipulation of, illustrative case of, 113
- inversion and adduction, 106
- Movement, limitation of, and mechanical locking, differential diagnosis of, 59
- at shoulder-joint, causes of, 124
- due to adhesions, distinction from active progressive disease, 22
- following sprain of internal lateral ligament of knee-joint, 47
- in diagnosis, 22
- Movements, early, after operative removal of semilunar cartilage, 67
- of elbow-joint, 133
- of fingers, 150
- of hip-joint, range of, 86-92
- of joints, normal range of, 40
- of shoulder-joint, 118-123
- of spine, 159, 160
- of thumb, 147-149
- of wrist-joint, 139, 140
- voluntary, after manipulation, 191, 192
- Muscle spasm causing deformity of shoulder-joint, 124
- due to stretching adhesions, 23
- fixation of elbow-joint by, 134
- Muscles, adductor, contracture of, 93
- scar tissue in, 93
- adhesions in, treatment of, 169
- electrical stimulation of, following manipulation, 192
- of back, 157, 158
- of calf, scar tissue in, illustrative case of, 170
- of groin, injury of, 92
- re-education of, after manipulation, 191

- Muscles, shortening of, adaptive,
 12
 secondary, 12
 tonic spasm of, 23
 Muscular substance, loss of, joint
 contracture following, 15
 system, injuries of, value of
 manipulation in, 168
 *Myeloma, danger of manipula-
 tion in, 189
 Myositis ossificans, danger of mani-
 pulation in, 26, 189
 in elbow-joint, 134
 rheumatic, 165
 traumatic and rheumatic, dif-
 ferential diagnosis of, 165

N

- Nerves, damage to, due to mani-
 pulation, 188

O

- Opposition of thumb, 149
 Orthopædic surgery, bone-setters
 recognised practitioners of, in
 early times, 1
 Osseous ankylosis, 14
 Osteopathy, notes on, 153

P

- Paget, Sir J., views on treatment
 by manipulation, 7
 Pain and tenderness following
 sprain of internal lateral
 ligament of knee-joint, 46
 in diagnosis of adhesions, 23,
 24
 Pannus in formation of adhesions,
 17, 18
 Paralysis, joint contractures in, 15
 Peri-articular adhesions, 12
 von Pirquet cutaneous reaction,
 27
 Plantar flexion of ankle, 104, 105
 Plaster and splints after manipu-
 lation of hip-joint, practice con-
 demned, 95
 Power, loss of, following sprain of
 internal lateral ligament of knee-
 joint, 47
 Pronation of foot, 106
 Pubo-capsular ligament of hip-
 joint, 85

Q

- Quadriceps extensor cruris, 42

R

- Radiant heat following manipula-
 tion, 192
 Radio-ulnar joint, inferior, 141
 articular capsule of,
 141
 synovial membrane
 of, 142
 triangular fibro car-
 tilage of, 142
 movements at, 142, 143
 superior, 133
 Railway spine, 161
 Re-education after manipulation
 of hip-joint, 95
 of shoulder - joint,
 126
 of spine, 166
 importance of, 30, 32
 Rest in treatment of joint affec-
 tion, doctrine of, 4, 5, 6
 Retinacula of hip-joint, 85
 Rheumatic lumbago, 162
 Rheumatism, adhesions in, 21
 Ribs, angles of, muscles attached
 to, 158
 Rotation of hip-joint, external, 89,
 90, 92
 internal, 89, 91, 92
 of knee-joint, 44
 of shoulder-joint, 120, 123
 Rotatory element in movements
 of spine, 160
 Royal College of Surgeons, founda-
 tion of, 1, 2

S

- Sacro-iliac joint, affections of, 175
 region, manipulation of, 184
 Sarcoma, danger of manipulation
 in, 189
 Scapula, adhesions of, 124
 and shoulder-joint, limitation
 of movement of, distinction
 between, 122
 movements of, 117
 Scar tissue, treatment of, 169,
 170
 Sciatica, manipulation in, 185
 Semilunar cartilage, "bucket-
 handle" lesion of,
 effects of manipulation
 on, 62, 64
 conditions of, amenable
 to manipulation, 65
 internal, anterior horn
 of, minor displace-
 ments of, 65

- Semilunar cartilage, internal,
fracture dislocation of, manipulation in treatment of, 80-83
lesion of, "bucket-handle," 60-64
complete longitudinal tear, 60
illustrative cases of, 67-69
manipulation of, technique, 80-83
pathology of manipulation in, 60
manipulation in chronic and recurrent lesions of, with differential diagnosis, 58
operative removal of, early movements after, 67
recurrent lesions of, mechanical locking in, 58, 59
repair in, experiments on, 58
extensions of, infrapatellar pad of fat, 66
menisci, 42
Semimembranosus, tendon of, 43
Shoulder-joint, adhesions in, tenderness due to, site of, 25
ankylosis, of, 124
operations for, 125
deformity due to muscle spasm, 124
lesions of, prevention of deformity after, 124
manipulation of, 122
illustrative cases, 127-131
long leverage, 125
short leverage, 127
technique, 125
movement and scapular movement, limitation of, distinction between, 122
movements of, 118
surgical anatomy of, 115
synovial membrane of, 117
Spine, adhesions of, 161
diagnosis of, 165
prevention of, 165
cervical region of, manipulation of, technique, 164
disabilities of, functional, manipulative treatment of, 165, 167
Spine, ligaments of, 159
lumbar, manipulation of, technique, 164
manipulation of, 153
after-treatment, 166
illustrative case of, 166
indications for, 161
movements of, 159
surgical anatomy of, 156
landmarks of, 159
tuberculosis of, manipulation contra-indicated in, 164
Sprains, adhesions in, 21
Subluxation of sacro-iliac joint, 175, 179, 180
reduction of, value of manipulative surgery in, 20
Supination of foot, 106
Suppuration, prolonged, joint contractures following, 15
Suprapatellar bursa, 42
pouch, delicate, adhesions in, following synovitis, 18
Surgery, manipulative, observations on, 1. *See also under Manipulative*
Swelling following sprain of internal lateral ligament of knee-joint, 46
Synovial effusion following sprain of internal lateral ligament of knee-joint, 46
membrane, 13, 14, 41
of ankle-joint, 101
of elbow-joint, 133
of hip-joint, 86
of inferior radio-ulnar joint, 142
of knee-joint, 41
of shoulder-joint, 117
of wrist-joint, 139
recesses in knee-joint, 41
Synovitis, hæmorrhagic effusion causing, 18
infective, manipulation in, 70
involvement of articular cartilage in, 16
liability to adhesions in, 12
toxic, manipulation in, 70
traumatic, adhesions in, symptoms of, 22
pain, 23
tenderness, 24
weakness, 24
manipulation in, illustrative cases, 71, 72
villous, manipulation in, illustrative case, 71

T

- Table for manipulative technique of hip-joint, 93
 Tarsal joints, manipulation of, 107
 movements of, 104-106
 Tenderness as symptom in diagnosis of adhesions, 24
 Tendo Achillis, 103
 Tendon, popliteus, 42
 slipped, manipulation in, 175
 Tendons, division of, joint contracture following, 15
 injuries of, manipulation in, 168
 peri-articular, of ankle-joint, 101
 Tennis elbow, manipulation in, 171
 varieties of, 171
 Tenotomy, subcutaneous, of adductor longus, 93
 Thigh, fractures of, mortality from, influence of use of Thomas's splint on reduction of, 4
 Thomas, H. C., teaching on orthopaedic surgery, 4-7
 Thomas's wrench in stiffness of mid-tarsal and ankle-joints, 110
 Thumb, joints of, 147
 movements of, 147-149
 range of extension of, 148
 surgical anatomy of, 147
 Tibio-fibular joint, 42
 Toe, great, manipulation of, 112
 metatarso - phalangeal joint of, manipulation of, illustrative case of, 114
 osteo-arthritis of, treatment of, by manipulation, 112
 Toes, flexors of, 103
 Traumatic lumbago, 162

- Tuberculous disease of joints, dangers of manipulation in, 26, 186
 diagnosis of, 26
 quiescent, diagnosis of, 28

V

- Vertebrae, cervical, unilateral dislocations of, manipulative treatment of, 166
 spinous processes of, muscles attached to, 158
 transverse processes of, muscles attached to, 158
 Volkmann's ischæmic contracture, 152

W

- Weakness as symptom of adhesions, 24
 Wrist-joint, abduction and adduction of, 140, 142, 143
 adhesions in, tenderness due to, sites of, 25
 deformity of, prevention of, 144
 flexion and extension of, 139
 manipulation of, 144
 illustrative cases, 145, 146
 technique, 145
 movements of, 139-143
 stiffness of, causes of, 144
 surgical anatomy of, 138
 synovial membrane of, 139
 Wry-neck, 163

X

- X-ray examination, importance of, 26
 of elbow-joint, importance of, 135

